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INDIA

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REPORT

ON THE

QUALITY MANUFACTURE & EXCISE-CONTROL

OF

ALCOHOLIC LIQUORS IN INDIA

BY

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A.

PRELIMINARY SECTION.

Chapter I.—Progress of the Enquiry.

CHAPTER I.

PROGRESS OF THE ENQUIRY.

Receipt of intimation regarding present deputation.

While on furlough in July, 1904, intimation was received from the Financial Secretary to the Government of India (in his No. 3914-Exc., dated 20th June, 1904), that, on my return to India, I was to be placed on deputation in order to conduct an enquiry into the quality of spirituous liquors made in India.

Government's instructions as to scope of enquiry.

The following general instructions were given, which I quote here for convenience of reference—

> In the first place, the object in view is to enable the Government of India to prescribe a simple and practical test for quality. It must be simple, for it will have to be applied in daily use to large quantities of liquor by untrained inexpert native establishments. It need not be of strict scientific accuracy, but it must be thoroughly practical so as to afford an assurance that any liquor which has successfully passed it is of really wholesome quality.
>
> Secondly, it must be remembered that the ingredients used in the manufacture of country liquor, and the processes commonly used differ widely in different parts of India, and the tastes and habits of consumers vary to an equal extent. It is essential that whatever standard or test may be prescribed shall not be such as to render the liquor unacceptable to the consuming classes, thus driving them to resort to illicit practices and defeating the object in view. It is also essential that the test shall not be of such a nature that it can be evaded by varying the ingredients or processes employed. In all probability you may find it necessary to propose a number of different tests, each applicable to a particular variety of liquor.
>
> Thirdly, if suitable tests can be devised, the Government of India propose, in the first instance, to introduce them in the areas to which the central distillery system applies, these being the areas in which measures of the kind in contemplation are likely to have the best chance of success. You should therefore direct your attention primarily to the varieties of liquor produced in those areas. It is not intended that you should wholly neglect the liquor produced in outstills, as it may be possible subsequently to apply some standard of quality to the latter also*. But the former should claim your earliest attention.

Distillery Inspections, etc., in Europe.

On receipt of the above orders, I took the opportunity to inspect the methods of manufacture in some of the best-managed distilleries in Scotland. From 1st September to 1st October 1904, I was placed on special duty in Europe and during that period inspected several distilleries and blending and refining establishments in Edinburgh, Leith, London, etc. While in London I selected two chemical assistants (MM. R. L. Jenks, F. I. C., and H. D. Perkins, F. C. S.); and chose the necessary apparatus and reagents for this enquiry.

I also paid a visit to the Paris Municipal Laboratories where special attention has been given to the subject of spirit-analysis.

Distillery inspections made in India.

On my return to India, I inspected the following distilleries on my way to Kasauli (which had been selected as the most suitable site for the Laboratory):

Bengal.—Russa, Burdwan, Bankipur.

United Provinces.—Allahabad, Cawnpore, Lucknow, Carew and Company's distillery at Rosa; and the Government distillery at Shahjehanpur.

On arrival at Kasauli, a suitable house was fitted up as a laboratory.

Subsequently a tour of the following distilleries was made :—

Central Provinces.—Akola.

Bombay.—Dhulia, Dadar, Uran (Mora).

Madras.—Bangalore (privately), Nellikuppam and Renigunta.

---

* The later decision of the Government of India as to the policy they propose to adopt with reference to outstills made it unnecessary to consider this question.

Start of Laboratory work.

The apparatus and chemicals arrived in time to allow of work being started in the Kasauli laboratory on April 3rd 1905.

Technical help to Mr. Todhunter, I.C.S., on Special Excise Duty in Central India.

On the 23rd May 1905, the Government of India authorised me " to render such assistance to Mr. Todhunter regarding the scientific and technological part of his special Excise Duty in Central India " as could be undertaken alongside my other work here. A number of references, nearly all necessitating special experimental work, were dealt with in this connection. In addition, the Excise Commissioners of various Provinces consulted me on various subjects and this also occasioned a good deal of extra experimental and other work.

Preliminary Note to the Government of India submitted in July 1905.

Explains the practicability of certain excise tests of quality.

On July 15th, I furnished the Government of India with a Preliminary Note on the progress of my investigations. The object of this note was to inform them as to the possibility of devising Excise tests of quality *should such prove necessary in the light of my subsequent enquiries*, and to outline a scheme for the proper working and control of such tests. It was explained in it that I had succeeded in modifying for Excise use two colour-tests for furfural and aldehydes, the classes of so-called " impurities " or by-products of spirits which the latest available work (that of Sir Lauder Brunton and Dr. Tunnicliffe) had indicated as probably the most important as regards noxiousness. It was obviously advisable to first ascertain whether such Excise tests could be devised before undertaking the considerable task of fully analysing samples of each of the varieties of spirits produced in all Indian distilleries. As regards these colour tests their limitations, degree of delicacy and accuracy, best and simplest methods of application, and the effect of interfering substances or conditions were ascertained. These tests as employed in the laboratory are much too difficult and delicate to be practicable for use as distillery-tests by Excise subordinates so that they had to be modified and much simplified without at the same time impairing their accuracy, etc.

A series of trials of the simplified Excise tests side by side with the Laboratory methods ultimately gave satisfactory results.

It was found impossible to obtain any method which could be applied as an Excise test for " fusel oil ". There are several processes which have been used for routine distillery-work, but these were conclusively proved to give very misleading indications, especially in the case of the types of spirits produced in India.

Cautions as to Patent-stills.

The Preliminary Note further directed attention to the difficulties encountered in certain distilleries in the United Kingdom which employ patent-stills owing to the relatively large proportions of aldehydes which may be produced from time to time in such spirits. This tends to show that the patent-still is not to be regarded as by any means necessarily the best mode of producing wholesome potable spirits as has been at times suggested in India.

Results of certain spirit analyses held over till final Report.

The results of 150 complete analyses of various types of spirit were available at the time of submission of the Preliminary Note but were not reported then as it was considered necessary to await the results of the physiological part of the enquiry before attempting to interpret the significance of the analytical figures.

Unsatisfactory state of Excise proofs of alcoholic strength.

Incidentally in the course of the work the unsatisfactory state of Excise control in the matter of proving spirits for alcoholic strength became evident. Inaccurate hydrometers were found to be widely in use and it was found that a considerable loss of revenue resulted from obscuration due to high degrees of acidity—a point that hitherto has apparently not been realised by Indian Excise Administrators.

Standard pattern of still-head devised.

It was understood that it was considered desirable that a suitable pattern of still should be devised so that efforts could be made to induce " distillers " and " out-distillers " to employ such with the view of improving the quality and also of diminishing somewhat the wastefulness of their present methods of distillation. I accordingly gave a good deal of attention to this matter and succeeded in devising a simple and efficient form of still-head which is capable of being easily and cheaply adapted to existing plant. Government, however, later considered that it would be undesirable to prescribe *for outstills* any standard pattern of still. The question yet remains to be settled as regards central distilleries. Standard patterns of still have apparently in some cases been prescribed for use in the United Provinces where English made pot-stills are in use in at least one distillery; and in certain distilleries in Bengal where the Deroy or Russa patterns have in the past found favour with the Excise administration.

Description of Excise quality tests and proposed means of control.

The methods for employing the colour tests were outlined and also a scheme for controlling their employment which included :—

(1) A course of instruction at some centre for Excise subordinates, in the practical application of the tests and in the elements of technical control of distillery-operations as well as of other technical Excise operations.

(2) Suggestions as regards allowing appeals by the distiller to a Central Excise Laboratory in case of disputes as to the tests.

(3) Control-analyses on samples collected at distillery-inspections by Excise officers.

(4) Control by a Central Excise Laboratory by obtaining samples at any time from distilleries.

In this way a very practical measure of control and supervision would have been exercised and both the local Excise administration and the Government of India would have been kept informed as to the state of control of quality throughout India.

Various other Excise control agencies.

The necessity which has frequently been urged by Excise administrators in India for the establishment of some central expert agency to assist the control of Excise operations, etc., was again briefly examined.

The questions of employing dyes for "ear-marking" spirits and opium that had paid Excise duty; and of exercising some degree of control as regards the quality of *retailed* country and also possibly of cheap imported spirits were also shortly dealt with, and suggestions were offered as regards the employment of expert Distillery Inspectors to be recruited from "practical distillers" at home and to be trained in India in their Excise duties. It was pointed out that a somewhat similar scheme had been working very successfully in Madras from several years past.

Appointment of Physiological Assistant.

On October 12th, 1905, Captain H. R. Nutt, M. B. (London), F. R. C. S. (England), Indian Medical Service, reported himself for duty as assistant in the physiological work of this enquiry. He continued on duty here until 30th April 1906.

Scope of enquiry enlarged by Excise Committee.

The Finance Department Resolution of 7th September, 1905, appointing the Excise Committee directed them to apply to me for such technical assistance on such matters connected with their enquiry as they might think requisite. These references very considerably increased the amount and scope of my work for, in addition to Indian manufactured spirits, I was required to investigate the quality (and certain other technical matters connected with the Excise) of the various fermented liquors produced in India and of cheap and other imported spirits and wines.

List of Reports submitted to Excise Committee.

THE FOLLOWING REPORTS WERE SUBMITTED TO THE EXCISE COMMITTEE :—

* Blending and Reduction Wastages.

(1) * "Dyeing" Distillery liquors for Excise identification.

(2) * Previous work concerning the physiological effects of by-products of alcoholic liquors.

(3) *List of questions drawn up for and circulated by the Excise Committee regarding drinking habits and the consumption of any specially noxious liquors used in India.

(4) * Preference for weak crude liquors to strong liquors equally diluted.

(5) * Comparison regarding by-products of country spirits with Indo-European and Imported spirits.

(6) * Brief notes on manufacture of distillery-spirits in use in India and suggestions for improvement of manufacture.

(7) *Behaviour of 60 Under Proof Dhulia Mahua liquor on keeping.

(8) *Obscuration in certain compounded spirits.

(9) * The quality of cheap imported spirits.

(10) * Some notes on the utilisation of Industrial Spirits and distillery waste-products in India.

(11) * Obscuration in Indian Excised Spirits.

(12) Proportion of fermented sugars in Russa spent wash.

(13) * Notes on Proposals to establish a Distillery School of Instruction and a Central Excise Laboratory for India.

(14) * The Dacca Distillery case.

(15) Quality of Penang Rum sent from Calcutta.

(16) * Accuracy of Excise Hydrometers, etc.

(17) Obscuration in certain out-still liquors.

(18) Analysis of a three years' old out-still liquor.

(19) * Poisoning of Bakhars of Pachwai and nature of certain yeasts in use by natives in making Rice Beers in Burma and other parts of India.

(20) * Changes in spirits of various types on keeping and casking.

(21) * Patent-and Pot-still systems.

(22) * Obscuration and Bonded Warehouses.

(23) * Influence of High Air Temperatures on spirit determinations.

(24) * Supplementary to Report No. 13.

(25) * Indian Spiced Liquors.

(26) * Decrease and Increase of Alcoholic strength in spirits on keeping.

(27) * Notes on "Kukra", a plant used to fortify liquor.

(28) * Fermented Liquors used in India.

Note—*Before a subject means that it has been included in the body of this Report in a more or less modified and extended form.

I also furnished the Committee with an advance copy of the Physiological Section of this Report. All these were supplied to them in time to allow them to be considered before writing their Report to Government. It will thus be seen that practically most of the information available in this Report has been already placed at their disposal by me in compliance with their request to furnish them with all the facts available at the earliest possible date.

Denaturalisation enquiry.

In addition to the foregoing, the Government of India directed me to investigate the subject of denaturalisation of Industrial Spirits and, if necessary, to devise a new denaturant. In connection with this I have had to examine the methods of denaturalisation employed in most countries and have devised a new method for the denaturalisation of spirit which it is believed will afford much greater protection to Revenue interests than any previous method used and will also, it is hoped, remove some of the difficulties which render spirit denaturalised by present methods in India undesirable for many industrial purposes.

This information has been embodied in a separate Confidential Report.

B.

CHEMICAL SECTION.

Chapter II.—Methods employed in this investigation.

Chapter III.—Results of Chemical Examination of Alcoholic Liquors in India.

CHAPTER II.

METHODS EMPLOYED IN THIS INVESTIGATION.

The first requisite was the preparation of chemically-pure alcohol and other reagents for this special work.

Preparation of reagents and alcohol of the requisite degree of purity.

Most of the chemical substances to be used in this enquiry were obtained from the best firms in London and Berlin and, though sent out as chemically "pure," nearly all were further purified by rectification, fractional distillation, etc. Further, a large amount of work was required in order to obtain the most rapid and complete methods for purifying certain materials largely employed. For example, alcohol had to be obtained absolutely free from all traces of by-products

(1) in order to prepare the standard solutions of aldehydes, furfural, "fusel-oil", etc., and

(2) for the physiological work.

It was thus found necessary to examine comparatively the existing methods for removal of by-products from alcohol in order to determine which was the most reliable and practical procedure to adopt for the preparation of pure alcohol from the generally somewhat impure rectified spirits procurable, and this preliminary work involved a long series of tedious fractional distillations with various reagents as well as the investigation of others which I thought might possibly get over the difficulties. In order to free alcohol from aldehydes, for instance, the following processes were tested :

1. Metaphenylenediamine hydrochloride (4 grams per litre).
2. Sodium phenylhydrazine parasulphonate (10 grams per litre).
3. Aniline Phosphate (4 grams per litre).
4. Caustic soda (1 gram per litre).
5. Sodium Amalgam, etc.

The alcohol in each case was first treated with alkali in order to remove ethers and also partly the aldehydes.

Then it had to be boiled under a reflux condenser for an hour ; then distilled and treated with one or other of the above-detailed reagents. It had then again to be boiled under reflux for another hour and redistilled and then tested to ascertain if it were free from aldehydes.

In deciding which of the above reagents should be employed, comparative experiments on a large scale had to be conducted and the spirit had to be finally distilled over in small fractions each of which had to be tested separately in order to ascertain when the spirit had become quite free from aldehydes. Fifty or sixty separate fractions were commonly collected and tested in the course of each such distillation and the different series had to be repeated many times before final results were obtained.

Great difficulty was also experienced with regard to obtaining reliable indications with the colour-test for aldehydes and on account of this the various series of fractional distillations above referred to had to be repeated several times which alone meant many weeks' work.

Then I found it necessary to devise a special method for removing all traces of "fusel oil" from that alcohol which was to be used for making up fusel standards (*i.e.*, weighed amounts of one or more "higher alcohols" in alcohol freed from all other higher alcohols) for the chemical and physiological work.

The above will serve to illustrate some of the preliminary difficulties which had to be overcome before the actual work of the enquiry could be even commenced.

Comparative examination of processes of spirit analysis.

Then came the question of the best analytical processes to employ. Other authorities are much at variance on this point and the question is one of considerable difficulty. It was, therefore, necessary to compare side by side the principal methods hitherto proposed for use in estimating the *groups* of by-products of spirits.*

For Furfural and Aldehydes.

As regards furfural, the colorimetric process with aniline acetate proved the only practicable method. For aldehydes a large number of comparative experiments were made with the metaphenylenediamine process and with the fuchsine bisulphite method and the decision was in favour of the latter on the score of delicacy, accuracy and general suitability though it is recognised that more than ordinary vigilance must constantly be exercised in order that the process may not give misleading results, and repeated failures and unexpected complications have taught us this fact only too plainly. The various modifications of the fuchsine bisulphite process had to be compared and the most suitable method determined.

Then these colorimetric processes for furfural and aldehydes had to be thoroughly examined as to their suitability for use as Indian Excise tests.

They had to be, as previously mentioned, simplified without impairment of accuracy, etc., and all possible fallacies or difficulties that might lead to trouble when the tests were worked by Excisemen *under ordinary Indian conditions* had to be exhaustively examined and precautions devised for nullifying any such dangers and inconveniences. I could not wait for the completion of the analyses of all distillery products in India and for the physiological results before working out these tests as the time-limit allowed did not permit of this.

Ethers and volatile bases.

The processes for ethers and also for volatile bases were compared and the most suitable practical methods worked out.

"Fusel oil."

The most difficult and lengthy series of comparative examinations was that in the case of the different methods for estimating the so-called "Fusel oil". This is a mixture of a number of higher alcohols and high boiling-point ethers, etc. To obtain a process that would *accurately* estimate its varied ingredients is a problem that has hitherto baffled chemists all over the world.

I had informed the Chief Commissioner of Assam in 1902 that "*the amount of fusel oil cannot be very accurately determined by any known process at present.*" That statement was based on a careful investigation of the subject at that time. Now, after the performance of some hundreds of *comparative* analyses on known amounts of "fusel" standards and on various types of spirits, as well as of several hundreds of analyses of spirits for fusel oil, I am still of the same opinion.

I have thus compared the—

(*a*) Sulphuric Acid method of Savalle ;

(*b*) Kamarowsky's modification of it ;

(*c*) Röse's Chloroform method in every form of the test published ;

(*d*) Beckmann's esterification method in its three modifications, and also with various means I devised to try to make it workable ;

(*e*) Allen-Marquardt's process.

The conclusion is clear: the first four are most misleading, Kamarowsky's perhaps least so, Röse's certainly most so.

Allen's modification of Marquardt's method as described in his standard work (Allen's "Commercial Organic Analysis," Volume I, pages 154-5) is, analysts complain, apt at times to give misleading results even with very careful working. I have modified some of the details as experience has accumulated and find that the process is certainly capable of yielding far more dependable results than any other. But, in spite of all, Allen-Marquardt's process cannot even yet be described as "very accurate." It utilises the solvent power of carbon tetrachloride for "fusel oil" and the latter is then oxidised to the condition of organic acids and so estimated.

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* It has been impossible to go further than this and to attempt any investigation of the proportions in which the various *members of each group* of by-products are present (except in the case of "fusel oil"). In the first place, no quantitative processes are (in certain cases) in existence for the purpose. Next, the proportions present in certain groups are too small to allow of any such attempt in general. The time required, moreover, for such pure research work would have extended over many years in all probability ; and the utility from the practical administrative point of view would have been very doubtful.

"Fusel oil" estimations.

But, for example, one of the ordinary constituents of fusel oil, *viz*., iso-propyl alcohol, is not oxidised to an organic acid but to acetone and so escapes detection. In the fusel oil *of patent-still spirits*, normal and iso-propyl alcohols are those which have been found in relatively preponderating amount. The method would, therefore, show the amount present of normal propyl but not of iso-propyl alcohol. But, in spite of this defect, there can be no doubt that by means of this modified Allen-Marquardt's process we are now enabled to determine *much more accurately than in any other way* the amount of "fusel oil" in potable liquors; and especially when amyl alcohol predominates as it does in most cases.

The German official process is Röse's Chloroform method. This is theoretically and practically quite untrustworthy. In any case the German official process makes no attempt to first remove aldehydes and substances other than "fusel oil", so that the whole procedure is irrational. As the Chloroform absorbs other substances besides "higher alcohols" it obviously must lead in many cases to a greatly exaggerated conception of the amounts actually present. Furthermore, like other workers, I have obtained by this process results which show "no fusel present" (in fact "minus readings" which, so to speak, show "less than no fusel present") although by direct fractional distillation *of the same sample*, as well as by Allen-Marquardt's process, I have obtained large amounts of fusel.

To explain this better I should add that the amount of fusel oil has finally been separated as such by repeated fractional distillations* and identified and weighed. The Röse process is still somewhat widely used in Germany and other countries. Many of the chemists who continue to use it apparently do so in despair of finding a better method,—Continental chemists being, as a rule, curiously ignorant of the existence of Allen-Marquardt's process though they know of the tedious and misleading *Marquardt* process.

It is remarkable how few of the chemists who use the Röse process appear to have examined its reliability by means of known fusel standards. Many appear to be content with the control test by means of alcohol (supposed to be fusel-free though it is obvious that the means usually employed to render it so could not possibly do this).

An illustration of the inaccuracy that results from the use of the Röse process may here be given: In Dr. König's "Chemie der Menschlichen Nahrungs- und Genussmittel," 1903, volume 1, page 1412, thirteen analyses of West Indian Rums by Professor Windisch (who has given special attention to spirit analysis and is considered one of the chief authorities in Europe on it) are quoted. In nine cases no fusel oil was found by the Röse process; in two cases the samples were stated to contain 0·031 and 0·026 per cent. of "fusel oil" by volume; and in two other cases to yield 0·022 and 0·031 per cent. West Indian Rums are well known to contain in general relatively high amounts of fusel and I have never met with an exception to this rule. Yet this well-known analyst working with the Röse method got in 11 cases *no fusel oil* and so to speak "*less than none*" (minus results); and in the four remaining cases moderate amounts.

Another example may be quoted. On the bottles of one of the best-known makers of Irish whiskey there is a certificate by a well-known public analyst to the effect that the whiskey (which is labelled "Pot still whiskey") contains "*no fusel oil, aldehydes*", *&c*. Now, there is no such thing as a genuine pot-still whiskey without some proportion of fusel oil and the same is true in almost equal degree of aldehydes. I can only account for this extraordinary and most erroneous statement by supposing that the analyst used Röse's process for, if so, the amount of fusel I found (on repeated analysis) to be actually present in the whiskey (258·3 parts per 100,000 of alcohol) might very well have been returned as "nil" or as a "minus quantity."

N. B.—* Fractionation of all my samples for fusel was impracticable and unnecessary. The estimation of "fusel oil" by fractional distillation in several hundreds of samples would have taken many years to complete.

This will sufficiently illustrate the condition of affairs in Europe as regards "fusel oil" estimations, etc.

I have, then, worked out comparatively these processes for the estimation of "fusel oil" with the different higher alcohols singly and in varying combinations as well as with many different samples of potable liquors. The methods have been repeated in this laboratory again and again in duplicate or triplicate and by different observers. In fact, no means has been left untried to test these methods as fairly and as exhaustively as possible.

The results now reported of my analyses of potable liquors as regards fusel oil *have been obtained by the modified Allen-Marquardt process* and of these there are very few that have not been checked by repeated analysis. I have confidence, therefore, in stating that the results have been obtained by what is by far the best available method worked under very exacting conditions. It may be of interest to add that the question of the best method for the determination of "fusel oil" has been engaging the attention of analysts at home to such an extent that the London Society of Public Analysts some years ago deputed Dr. Philip Schidrowitz to comparatively examine the merits of the various processes. A paper published by him towards the end of my work indicates that his results support the conclusions I had independently arrived at, that Allen-Marquardt's process is alone capable of giving approximately accurate results.

It must be borne in mind that I was anxious to find a method *for Excise routine employment* which would give even an approximately fair estimate as regards "fusel oil." I approached the subject with the desire to obtain as simple and as workable a process as possible not only for the foregoing reason but in view of the very limited time at my disposal in which to conduct the many hundreds of full analyses necessary in the examination of the alcoholic liquors produced throughout India.

The Allen-Marquardt's process takes fully three days to complete and is by far the most difficult and tedious of the methods for estimating fusel oil. Its adoption, therefore, in view of the limited time and small staff available, was the one least desired by me. But there was no alternative in the matter as the other processes proved quite misleading, whereas, by means of the indications given by fusel-standards in known amounts and by fractional distillation of potable spirits, the comparative accuracy of the modified Allen-Marquardt process was clearly established.

Unnecessary to give technical details of processes employed.

It would seem to be out of place to describe here details of the analytical processes employed in this enquiry as they are of too technical a nature to be of any interest except to analysts.

Analysis of products of all Indian distilleries.

Having ascertained which processes were most reliable the next step was to fully analyse* every product of each distillery throughout India. It must not be supposed, however, that the confidence above referred to in the practical accuracy of the methods adopted had been entirely gained before the routine analyses were commenced. Much had necessarily to be taken at first on faith so as not to unduly delay the provisional report made in July last, but the original outlines adopted for each method remained unchanged and, when greater accuracy had been obtained by modifying the original details as required, the earlier analyses have, as far as possible, been brought up to the same general level of accuracy as the later by repetition under the new conditions.

In any survey of the condition of Indian-made liquors as regards wholesomeness it would have been very unsatisfactory merely to select "at random" samples for analysis of the different types of liquors produced, as was proposed by Government originally. This would have led later to criticisms to the effect that while no doubt the samples analysed were of the quality indicated yet had samples from such and such distilleries been also analysed very different opinions would have been formed, etc. It has therefore seemed best to make the enquiry as thorough as possible in the time allowed. Having thus analysed the products of all Indian distilleries and as many of the other classes of liquor as time would permit we can rely on having obtained a very comprehensive view of the real state of matters, and a sufficiently wide basis for deductions.

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* Each analysis for by-products takes at least three to four days to complete and such extra analyses as for volatile bases and (in the case of fermented liquors) for sugars, albuminoids, tannin, etc., occupy several more days.

Summary of analyses performed.

In the Appendix to this Section will be found the results of the complete analysis for by-products of the various classes of liquors obtainable in India; and where necessary (as in fermented liquors) for such extra constituents as sugar, albuminoids, tannin, etc. The totals are as follows :—

355	Country spirits (exclusive of 7 from Native States).
38	Indo-European spirits.
84	Imported spirits of ordinary quality.
27	Imported spirits of cheap quality.
58	Washes and "aldehyde increase" experiments, etc.
54	Native fermented liquors (toddy, rice beers, etc.)
56	Beers made by European firms in India.
22	Imported beers and Miscellaneous liquors.
26	Wines of various types.
10	Liqueurs.

The total of 730 analyses shown in these lists, considerably understates the number actually made for it has already been explained that a large number of the analyses have been repeated and further that a very extended series of comparative analyses was made on standard solutions of by-products and on selected spirits in order to determine the most suitable analytical methods. The total number of analyses made, therefore, amounts to well over 2,000. It has been a matter of much difficulty to arrange for the completion of this number of long and complicated analyses in the relatively brief time at my disposal and it has only been possible to do so by thoroughly systematising the arrangements so as to enable us to conduct a large number of analyses concurrently and by working at very great pressure throughout the whole course of the enquiry.

Method of tabulation of analytical results.

The results of these analyses have been tabulated so as to show—

(1) the influence of the fermentative basis and the particular methods of manufacture on the resulting proportions of by-products, etc. ;

(2) the relative amounts and limits for these by-products in the different types of spirits ;

(3) incidental points such as the amount of obscuration of alcoholic strength and inaccuracies in Excise hydrometers ;

(4) in the case of fermented liquors, the approximate nutritive value of the various liquors.

In this way we are enabled to contrast the different classes of alcoholic liquors obtainable in India ; to form estimates as to their relative wholesomeness ; and of the accuracy or otherwise of the Excise methods of control of Revenue especially in the matter of levying duty on alcoholic strength.

The results are stated in (*a*) grams per litre ; (*b*) in milligrams per 100 cubic centimetres of absolute alcohol (approximately, parts per 100,000 of absolute alcohol) ; and (*c*) in grains per proof gallon

Other technical Excise enquiries conducted.

In addition to the foregoing, a number of enquiries have been conducted on other matters relating to Excise control as for example :

Certain spirit wastages.

The subject of Wastages connected with Reduction and Blending and on which a note was submitted to the officers who had applied for assistance in the matter.

Dyeing distillery liquor.

A number of spirit-dyes and dyed liquors were at different times analysed and reported on for the Bengal Excise Commissioner's information.

Obscuration.

The question of obscuration was examined and reported on in relation to Excised liquors and also incidentally a method has been devised which will prevent the comparatively heavy loss of revenue which has occurred for several years past in the Customs by faulty technique in conducting the obscuration tests. In connection with this a number of important practical results have been obtained regarding the influence of high air temperatures in India on spirit determination.

Dacca Distillery case.

An enquiry was also carried out in connection with the Dacca Distillery where a number of seemingly anomalous results were being obtained.

Excise hydrometers.

Types of Excise hydrometers and of saccharometers from different Provinces were examined and reported on.

Poisons in *bakhar, pachwai*, etc.

A number of analyses for poisonous additions to *bakhar* and *pachwai* were made.

Yeast examinations.

A large number of yeast examinations and culture-experiments were conducted in the case of the yeasts found in native fermented liquors and on certain samples of Chinese yeast used in Burma.

Maturation analyses.

A series of analyses was made at intervals to determine the changes which occurred in spirits of various types on being matured in bottle or jar and also in cask.

Increase of alcoholic strength on storage.

Another series of experiments, extending over some months, was made with reference to the evidence produced by certain Excise Officers that spirits stored under certain conditions showed an *increase* in alcoholic strength.

Composition of fusel oil in certain Indian types of spirit.

A series of fractionations of "feints" from patent stills and of various types of spirits were made so as to ascertain the components of their "fusel oil," *i.e.*, the proportions in which the various ingredients of fusel oil were present in Indian spirits. These analyses have generally taken many weeks or even two or three months of constant work to complete on account of the large number of fractional distillations involved. The separation of the essential oil of mahua-flowers and spirit may also be mentioned as another lengthy piece of work carried out.

Physiological section of the work.

The methods employed in the physiological portion of this Investigation have been described in Chapter VI. In all over 1,000 experiments on men and animals were conducted in connection with this section of the work. Certain other enquiries which were conducted, partly by means of physiological experiments, were, for example, that regarding "Kukra" (*Polygonum flaccidum*) a plant said to be used in Assam for increasing the intoxicating action of liquor; and with the new denaturing agent under consideration for use in India; etc.

Technological work.

A considerable amount of work has been carried out in connection with certain technological aspects of this enquiry. This need not be here detailed as it will in some measure, become evident later when discussing the means for improving the manufacture of spirits in India, etc.

CHAPTER III.

Results of Chemical Examination of Alcoholic Liquors in India.

Chief Groups of By-products in Spirits.

Ordinary or Ethylic Alcohol is obtained by the fermentation of sugars brought about by the action of various kinds of yeast-cells, chiefly of the type of *Saccharomyces cerevisiæ.*

The yeast splits up the sugar into alcohol and carbonic acid gas (and small amounts of glycerine, succinic acid, etc.), and besides these a number of by-products may be produced, chief among which are:—

"Fusel oil."

1. "Homologous alcohols of the fatty series," also called "*higher alcohols,*" and represented chiefly by propyl and isopropyl alcohol; butyl and isobutyl alcohol; iso-amyl alcohol; hexyl, heptyl and octyl alcohols; etc. These chiefly constitute the so-called "fusel oil."

"Aldehydes."

2. *Aldehydes* produced by the partial oxidation of these alcohols and chiefly consisting of acetic aldehyde which is derived from ordinary (ethylic) alcohol. Propyl, butyl, and amyl aldehydes are also found in relatively lesser amounts and others in generally quite insignificant traces. Another very important aldehyde is pyromucic aldehyde or furfur-aldehyde (*furfural* or furfurol) which results from the action of the hot, acid, alcoholic liquid on vegetable fibres.

"Ethers."

3. *Ethers* ("*Compound Ethers*" *or* "*Esters*").—These are produced by the combination of various acids with the various alcohols. Here, again, as Ethylic alcohol is chiefly present in alcoholic liquors the predominant ether found is acetic ether (formed by the combination, on the one hand, of the acetic acid which is produced by oxidising alcohol beyond the acetic aldehyde stage and, on the other, of ethylic alcohol). We have, next in amount, butyric ester, then valeric, then propionic, etc.

"Acids."

4. *Acids.*—The acids in spirituous liquors are (*a*) *volatile* and (*b*) *fixed.*

Volatile Acids—are chiefly formed by the oxidation of the various forms of alcohol present, the relation being, *e.g.*,

Alcohol (Ethylic)
oxidised to
Aldehyde (*acetic* aldehyde)
and then to
Acid (*acetic* acid).

Acetic acid is also formed directly by a special micro-organism and especially when the temperature of the fermenting wash becomes too high.

Another class of acids formed is derived in the case of spirits from absorption of acids from the casks in which the spirits have been kept. These are termed *Fixed Acids* as they do not distil over but are left behind in the still, being non-volatile.

It has been stated that about 6 per cent. of the sugar present is converted into these by-products (excluding the last mentioned) but such a statement is obviously to be applied with special caution to Indian conditions when we consider the great variations due to the influence of dissimilar manufacturing processes, temperature, yeasts and other micro-organisms, etc.

In the following report the term "aldehyde" refers not to a single substance but to the *group* of aldehydes which respond to the general chemical test for these substances (excluding furfural).

For brevity, the term "fusel" has been used in general throughout as very conveniently designating a large group of chemical substances comprising higher alcohols, high boiling-point ethers, and other substances which are conventionally included under the expression "fusel oil."

In the analytical tables—the term "fusel oil" means higher alcohols only, because the ethers are removed as a preliminary step in Allen-Marquardt's process.

"*Acids*" refer in the case of spirits to volatile acids as the samples were found (as was to be expected) to contain no *fixed acids* when sent straight from the distillery in bottle or jar and without having been casked. Nearly all our samples conformed to these conditions.*

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* In beers or wines the total solids, ash, mineral constituents, glycerine, colouring matters, dextrin, etc., have not been estimated not only as being of little practical use for our present purpose but because time did not permit of such an extension of the scope of our analyses.

Volatile Alkaloids.

Volatile alkaloids.—These belong largely to the pyridine series and have hitherto been chiefly found in spirits made from beets. It is sufficient to say that in none of the spirits I have examined has any trace of these bodies been found.

Volatile oils.

Volatile Oils may occur naturally as in *mahua* or as added flavouring essences, *e.g.*, anise, peppermint, cardamoms, etc. In the case of fermented liquors (such as beers), sugars and albuminoids have also been estimated; and in wines, sugar and tannin and fixed acids (which last are derived from the fermented must or from the cask and are not separated by distillation as in the case of spirits).

RESULTS OF ANALYSIS OF SPIRITS.

Country spirits.

Country spirits (*i.e.*, spirits made in India by native processes) and *Indo-European spirits* (*i.e.*, spirits made in India by European or *quasi*-European methods) have been *contrasted with Imported spirits* of "high class" or "ordinary" quality obtained from firms of the highest standing in Great Britain, and in India from the best European firms in Calcutta, Bombay, Lahore and other places.

The term "Imported spirit" is throughout used solely with reference to this class; and any reference to the special class of cheap imported spirits is always prefixed by "*Cheap*".

Cheap Imported spirits.

Cheap Imported spirits have been dealt with separately.

The detailed results are shown in the Appendix to this Section. (The names of the manufacturing and retail firms concerned have been supplied separately under a confidential cover).

Classification of country spirits' analyses.

The country spirits have been classified according to:—

(*a*) the fermentative basis used;
(*b*) the method of heating the still (fire or steam);
(*c*) and as to whether the spirit was singly or doubly distilled.

The classification as to the fermentative bases used is as follows:—

(1) *Mahua*, including mixtures of *mahua* with *gur*, *shira*, molasses, etc.
(2) Rice, Raisins, Date and Toddy spirits.
(3) Cane-*gur*; Date-*gur*; Date-*chitta* and cane-*gur* mixed; molasses, *shira*, *jaggri* ("Jaggery") spirits.§
(4) Miscellaneous (spiced, flavoured and coloured variously).*
(5) A few spirits from Native States (sent by Mr. C. G. Todhunter I.C.S., when on special Excise Duty in Central India).

By such comparison it has been possible to ascertain whether a preponderance of any special group of by-products or combinations of groups is associated with any particular fermentative basis or mode of distillation. The analyses further give us information of great practical value as regards the defects in the method of production of spirits and help to indicate the best mode of improving manufacture.

Basis to which calculated.

The results are calculated for example in milligrams per 100 cubic centimetres of absolute alcohol which corresponds approximately to *parts per 100,000 of absolute alcohol.* The necessity for calculation to a fixed amount of absolute alcohol (by which term is here meant pure or "100 per cent. alcohol)† will be evident when the varying strengths of liquor analysed are considered.

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* Spirits flavoured in order to imitate imported spirits such as whiskey, brandy, gin and rum are not here included but come under the head of "Indo-Europeen spirits".

† "Absolute alcohol" in commerce means a spirit stronger than can be got by repeated distillation without special dehydration by chemicals.

Absolute alcohol of the British Pharmacopia is 99 per cent. alcohol and contains not more than 1 per cent. by weight of water.

§ *Mahua* the dried flowers of *Bassia latifolia*, &c.

Gur is *solid* (crystallisable) sugar refuse (chiefly from sugar-cane but also from date-palm).

Jaggri is the solid sugar refuse from the date palm, palmyra, cane, &c.

(The term is generally applied to a more refined variety of *gur*).

Chitta or *chotta*, *shira* and *molasses* the fluid (uncrystallisable) sugar refuse.

Toddy ("tadi" or "tari") the sap of different varieties of palms. It is consumed "fresh" (sweet) and "fermented." When distilled it constitutes "arrack." This term is used as a synonym for "country spirit" in various parts of India.

Standard of average daily consumption for India.

The figures in brackets in the first column of the following summary-tables represent the corresponding amount of the particular by-product in grams per *Imperial quart of 60 U. P. spirit*, which has been taken as a convenient *fixed* unit for comparison (as the "reputed" quart varies in amount) and as very approximately representing the daily maximum consumption per head all over India. This standard was fixed several months ago (when reporting to the Excise Committee on my results up to that date) but the results of the local enquiries made later throughout India at the Committee's instance and recently received, collated and reported on by me to them appear to indicate that *the average daily consumption*, so far as it is possible to obtain any such figure, *is from quarter to half a "bottle" or "reputed quart."* This would represent from about 6 to 12 fluid ounces of liquor (as against the 40 ounces of the Imperial quart) of 60 U. P. liquor. The severity of my standard thus becomes evident and the conclusions I am enabled to draw should thus be correspondingly enhanced in weight.

It may further be noted that these country spirits are "genuine pot-still spirits." In Britain a few firms still sell genuine pot-still spirits but the practice has grown up of largely "blending" such pure pot-spirits with patent still spirits which contain much smaller amounts of by-products. For example, it seems probable that of the imported whiskeys used as a standard for comparison one-half contain 50 per cent. or more of patent-still spirit, *i.e.*, their original proportions of by-products are diluted to that extent. So that had the comparison been made some years ago the country spirits would have compared even better, as "all pot-still spirit" would then have been compared with the like. It was thought desirable, however, to compare them with *what is commonly drunk in the United Kingdom* at the present time.

Comparison between Imported, Indo-European and country spirits.

A comparison may now be made between the three chief classes of spirits met with in India, *viz.*, "Country", "Imported" and "Indo-European" as regards the relative proportions of by-products occurring in each.

ACIDITY.

Classification in groups according to increasing acidity.

Milligrams per 100 c. c. of absolute alcohol (parts per 100,000 approximately).	Country spirits.		Imported spirits.		Indo-European spirits.	
Spirits containing :—	No.	Per cent	No.	Per cent.	No.	Per cent.
Up to 100 per 100,000 (=·26 gram per quart) ...	63	18	83	99	32	84
100—300 per 100,000 (300=·78 gram per quart) ...	137	39	1	1	3	8
300—500 per 100,000 (500=1·3 gram per quart) ...	71	20	...	...	2	5
500—800 per 100,000 (800=2·08 gram per quart) ...	50	14	...	...	...	...
800—1,200 per 100,000 (1,200=3·12 gram per quart) ...	20	6	...	...	1*	3
1,200—2,000 per 100,000 (2,000=5·2 gram per quart)...	9	2	...	...	...	...
Above 2,000 per 100,000	5	1	...	...	...	...
Total spirits analysed= ...	355	100	84	100	38	100

* Due to low alcoholic strength *viz.*, 81° U. P.

Degree of Acidity indicates nature of manufacture.

The degree of acidity of a spirit gives an excellent general idea of the degree of skill and care employed in its manufacture. An acidity above a certain limit for any given degree of alcoholic strength indicates a faulty fermentation and defective distillation. Whereas *per contra* a low acidity indicates clean and satisfactory fermentation and efficient distillation. The above table illustrates this principle well. The usually well made imported spirits have acidities under 100 parts per 100,000 of alcohol in no less than 99 per cent. of the samples examined. In only one case was this amount exceeded. The Indo-European spirits which again excel country spirits in general in the matter of manufacture but which in many cases fall below the European standard have 84 per cent. (as against the Imported spirits, 99 per cent.) showing acidities under 100 parts per 100,000, and 16 per cent. which exceed this limit.

Country spirits on the whole much the most acid.

When we compare the country spirits' acidity with that of the other two classes, the contrast is very marked. Whereas 99 per cent. of imported and 84 per cent. of Indo-European had less than 100 parts of acid per 100,000, the country spirits have only 18 per cent. below this limit: a most unfavourable comparison, of course, and one which points to the crudity of the processes and the lack of technical skill in the native distiller in general. Whilst there is no doubt that the amount of acid generated in the wash is excessive in the case of country spirits, the result is usually enhanced by undue prolongation of distillation—in fact to a point long after that at which the distillate has ceased to contain alcohol. Water and acetic acid are at this period of distillation the main volatile substances distilled over. A greater pungency of flavour is thus obtained than when the distillation is stopped at the proper stage and the spirit then diluted as required with water. No doubt, also, the practice arises from ignorance as to when the alcohol has ceased to distil over. The range of acidity is very great and attains enormous proportions in several cases. This high degree of acidity is one of the two chief counts against Country Spirits, but is fortunately one which, as will be shown later, is remediable by the means presently to be indicated.

High acidity due to low alcoholic strength.

High acidity due to initially low alcoholic strength.—The above table is somewhat complicated by the existence of another factor to which due weight must be given when considering this aspect of Country Spirits. When the alcoholic strength is initially low a further acidification takes place, *i.e.*, the liquor sours on keeping. The liquors examined were obtained as fresh as possible, but in some cases, at all events, this souring process had set in and this fact somewhat exaggerates the relation shown in the table. That alcoholically weak spirits sour more extensively than strong spirits has been found to be generally true. Definite exceptions, however, were observed, (*i.e.*, non-souring of certain weak spirits and comparative souring of strong spirits) and this indicates that other causes, *e.g.*, defective conditions of manufacture, promote souring which is thus seen to be not merely or necessarily due to an initially low alcoholic strength. There is definite evidence that well-made Indian spirits, even of weak strength, keep well in comparison with European spirits.

RELATION BETWEEN EXTREME DISTILLATION AND ACIDITY.

Acidity (country spirits) arranged according to strength.

Strength.	About 25° U.P. (*i.e.*, 20°—30° U.P.)	About 40° U.P. (*i.e.*, 35°—45° U.P.)	About 50° U.P. (*i.e.*, 45°—55° U.P.)	About 60° U.P. (*i.e.*, 55° U.P. and below.)
Number of samples examined ...	127	24	37	62
Percentage containing— Under 100 parts per 100,000 alcohol	20%	8%	*Nil.*	5%
100—300 ditto	44%	37%	16%	14%
300—500 ditto	24%	21%	30%	20%
500—800 ditto	10%	25%	30%	29%
800—1,200 ditto	2%	9%	21%	11%
1,200—2,000 ditto	*Nil*	*Nil*	3%	13%
Above 2,000 ditto	*Nil*	*Nil*	*Nil*	8%
Total ...	100%	100%	100%	100%

Acidity's relation to over distillation.

The above table indicates the relationship existing between increasing acidity and low alcoholic strength. The samples from 20 to 30 U. P. gave the lowest acidities; and the progressive increase in acidity as the alcoholic strength becomes less is very distinctly brought out in the other three columns.

" Keeping powers " of country spirit.

Keeping powers of Country spirits.—The following statement shows the results of examination of 25 U. P. spirits (which is the minimum legal strength for Brandy, Rum and Whiskey in Britain), after being stored in bottle or stone jar from 4½ to 7½ months. In two cases out of six there was a diminution of acidity and in the remainder a slight increase.

ACIDITY.

The acidities are stated in milligrams per 100 c. c. of absolute alcohol

(or in parts per 100,000 approximately.)

Basis, name and strength.	Acidities on : 1905.		Acidities on 14th February 1906.	Approximate number of months kept before re-examination.	Acidity increase (+) or decrease (—).
(1) Surat plain *mahua*, 25° U. P. ...	19th June ...	57·5	61·1	7½	+ 3·6
(2) Ahmedabad *mahua*, 25° U. P. ...	Ditto ...	8·2	13·7	7½	+ 5·5
(3) Godhra *mahua* steam heated, 25° U. P. ...	24th June ...	84·9	95·9	7½	+ 11·0
(4) Satara *mahua*, double distillation, 25° U. P.	8th August...	61·5	46·8	6	— 14·7
(5) Belgaum *mahua*, 24·8° U. P.	11th August	92·1	83·7	6	— 8·4
(6) Chanda *mahua*, 25° U. P.	25th September.	73·9	80·7	4½	+ 6·8

REMARKS.—All samples were stored in bottles except No. 3, which was in stone jar.

In order to institute a comparison with the above Indian samples in this respect five samples of Scotch and one of Irish whiskeys which had been kept here for from 4 to 5 months were re-examined for acidity (and ethers) with the following result.

(The results are, as usual, stated in parts per 100,000 of absolute alcohol.)

Nature and strength of spirit.	Original acidity.	Original amount of ether.	Acidity 4 to 5 months later.	Ethers 4 to 5 months later.
Special liqueur Scotch whiskey 12·8 U. P.	23·1	84·9	29·0 (+5·9)	84·9
Old vatted Glenlivet whiskey (special reserve) 14·9 U. P....	42·5	115·8	38·5 (−4·0)	80·2 (−35·6)
Old Highland Whiskey 13·8 U. P.	54·2	104·4	54·2	104·4
Special Old Highland Whiskey 14·5 U. P.	48·0	123·2	48·0	104·0 (−19·2)
Scotch Whiskey 13·5 U. P.	17·8	34·9	65·5 (+47·7)	103·2 (+68·3)
Irish Whiskey 13·5 U. P.	23·9	43·8	71·7 (+47·8)	168·5 (+124·7)

Of the 6 Indian spirits, therefore, four slightly increased and two decreased in acidity in from 4½ to 7½ months. In the 5 Scotch and 1 Irish Whiskeys three increased in acidity, two remained unaltered and one decreased in acidity.

Relation of Ethers' Increase to Acids' decrease on keeping.

The relation of ether formation to acid-decrease on keeping is not so simple a question as has hitherto apparently been supposed and this latter series of analyses (as well as several other series of analyses made by me for a similar purpose) bears out this statement.

(*a*) In two whiskeys, the ethers remained unaltered while in one case there was an increase of acidity and in the other none.

(*b*) In two cases the ethers markedly decreased while in one of these the acidity also decreased and in the other remained stationary.

(*c*) In two cases the ethers considerably increased while in both cases the acid (coincidently) increased in the same degree in each case.

It is, therefore, best to reserve any opinion on the question of diminution of acidity being necessarily, or even usually, associated with an increase of ethers till a very large number of such special analyses can be accumulated to serve as a basis for deductions.

An even stronger proof of the keeping-powers of some low-strength spirits is afforded by the case of the 60 U. P. *mahua* spirit made at the Dhulia Distillery. It was found that this spirit did not sour or otherwise spoil on keeping as is the case with spirits of that and even much higher strengths produced in other Indian distilleries. In order to test the accuracy of this statement I carried out the following experiments:—

Dhulia, 60° *U. P.* mahua *spirit.*

	—	Acidity in milligrams per 100 c c. absolute alcohol (parts per 100,000 approximately).	Loss per cent. of acidity.
I	Examined on 22nd May 1905	367·1	
	Re-examined same sample 16th February 1906	337·1	8·7
II	Sample examined on 16th January 1906	706·6	
	Re-examined same sample 16th February 1906	669·4	5·6
III	Another sample distilled from the same wash as No. II and examined on 16th January 1906.	681·8	
	Re-examined on 16th February 1906.	681·8	*Nil.*

Sample No. I was sent in a stone jar with screw-stopper. It was repeatedly opened to remove portions for analysis at various times. In spite of this exposure it kept perfectly well and has improved in quality.

Samples Nos. II and III were sent and kept in bottles with ordinary corks. Both these samples were opened for examination at intervals of a month, and here again no souring whatever occurred, but on the contrary the acidity decreased or remained unaltered. These experiments go to show that care and cleanliness in the various stages of manufacture largely determine the keeping qualities of a spirit and not (*i.e.*, within certain limits, of course) mere alcoholic strength.

I have only to add that I examined all the Dhulia 60° U. P samples for the presence of added preservatives and that none could be detected. The Distillery Inspector at Dhulia further stated that no preservatives had been added to the spirits.

One of the chief difficulties of Indian Excise administration has been the fact that the weak, crudely-made Country spirits would neither keep nor carry without spoiling and that the demand for such spirit is great in certain parts of India. The question is more fully dealt with later, but it may be here stated that the above-quoted results obtained in the case of the Dhulia 60 U. P. spirit show that with a reasonable amount of knowledge, care and skilled supervision there should be no difficulty in producing in Indian distilleries a spirit that will keep and carry perfectly well, the main point being to keep down the acidity in the wash.

Indo-European spirits.—Only six samples (16%) had acidities over 100 parts per 100,000 and these are here detailed.

Indo-European spirits Acidity.

		Acidity: parts per 100,000 of alcohol.
1	Karnal Plain spirit, L.P.	170·4
2	Tadpatri Jaggery, 20·6° U.P.	282·1
3	Sujanpur Gin, L.P.	102·1
4	Bellary Jaggery, 30·2° U.P.	302·9
5	Bellary Jaggery, 20·0° U.P.	233·3
6	New Eden Jaggery, 81° U.P.	1,158·3

Here Nos. 1, 2, 4 and 5 appear to have soured through bad manufacture as their alcoholic strengths were relatively high. No. 6 was too weak alcoholically to keep, but the details of its manufacture show that it cannot be regarded as a well-made spirit. (No. 3 is just over the limit and calls for no special comment.)

FURFURAL.

Furfural.

This by-product (along with acidity) is generally present in much too high proportions in country spirits as a class, as is shown by the following :—

FURFURAL.

Classification in groups according to increasing furfural-content.

Milligrams per 100 c. c. of absolute alcohol (parts per 100,000 approximately).	Country spirits.		Imported spirits.		Indo-European spirits.	
	No.	Per cent.	No.	Per cent.	No.	Per cent.
Under 1 per 100,000 (1 = ·0026 gram per quart) ...	34	10	28	33	18	47
1—3 per 100,000 (3 = ·0078 gram per quart) ...	69	19	39	46	8	21
3—6 per 100,000 (6 = ·0156 gram per quart) ...	78	22	14	17	6	16
6—10 per 100,000 (10 = ·026 gram per quart) ...	83	23	3	4	4	10
10—20 per 100,000 (20 = ·052 gram per quart) ...	78	22	...	...	1	3
20—30 per 100,000 (30 = ·078 gram per quart) ...	11	3	...	...	...	...
30—40 per 100,000 (40 = ·104 gram per quart) ...	2	1	...	...	...	...
Above 40 per 100,000	...	...	...	...	1	3
Total spirits analysed = ...	355	100	84	100	38	100

Country spirits the worst class as regards furfural-content.

10 per cent. of country spirits, 33 per cent. of Imported and 47 per cent. of Indo-European *were free from any trace of furfural.* In the higher proportions the comparison between country spirits and the other two classes is decidedly in favour of Imported Spirits which latter in no case exceed 10 parts per 100,000 and of Indo-European in which one sample only exceeded this amount. On the other hand 26 per cent. of the country spirits had over 10 parts of furfural per 100,000. The significance of these figures will be later dealt with but here again it may be noted that improved manufacture will remove the defects of country spirits as regards furfural as in the case of acids.

Relation of high acid and furfural production to each other.

The association of furfural and acids in relatively high proportions in spirits is shown by the evidence contained in Chapter XV of this Report and the further significance of these figures may be more appropriately considered then.

ALDEHYDES.

Classification in groups according to increasing aldehyde-content.

Milligrams per 100 c. c. of absolute alcohol (parts per 100,000 approximately).	Country spirits.		Imported spirits.		Indo-European spirits.	
	No.	Per cent.	No.	Per cent.	No.	Per cent.
Nil	33	9	1	1	3	8
Under 25 per 100,000 (25 = ·065 gram per quart) ...	240	68	69	82	23	61
25—50 per 100,000 (50 = ·13 gram per quart) ...	69	19	10	12	10	26
50—100 per 100,000 (100 = ·26 gram per quart) ..	11	3	4	5	2	5
100—150 per 100,000 (150 = ·39 gram per quart) ...	...	...	...	...	...	...
Above 150 per 100,000	2	1	...	...	...	...
Total spirits analysed = ...	355	100	84	100	38	100

Aldehydes.

Country and Indo-European spirits in respectively 9 and 8 per cent. show an entire absence of aldehydes while only in 1 per cent. of imported spirits are they absent. Again 82 per cent. of imported spirits, 68 per cent. of country spirits and 61 per cent. of Indo-European spirits had the very moderate proportions of under 25 parts per 100,000 and in the higher range the differences between the three classes are practically unimportant. Thus Country and Indo-European spirits compare favourably, on the whole, as regards aldehydes with imported spirits. It is reasonable to suppose that the high temperatures prevalent in this country and the generally faulty methods of condensation in the case of Country Spirits favour the escape of aldehyde, in comparison with the conditions existing in temperate climates.

"FUSEL OIL" ("HIGHER ALCOHOLS".)

Classification in groups according to increasing fusel-content.

Milligrams per 100 c. c. of absolute alcohol (parts per 100,000 approximately).	Country spirits.		Imported spirits.		Indo-European spirits.	
	No.	Per cent.	No.	Per cent.	No.	Per cent.
Under 100 per 100,000 (100= ·26 gram per quart) ...	86	24	21	25	12	32
100--200 per 100,000 (200= ·52 gram per quart) ...	155	44	46	55	18	47
200—300 per 100,000 (300= ·78 gram per quart) ...	75	21	12	14	5	13
300—400 per 100,000 (400=1·04 gram per quart) ...	24	7	3	4	2	5
Above 400 per 100,000	14*	4	2	2	1	3
Total spirits analysed= ...	354	100	84	100	38	100

* *Note to Table.*—To illustrate the connection between weak spirits and high fusel proportions it may be added that of these 14 samples there were:—

Above 30 U. P. ... ... =2 samples;
At and below 40 U. P. but above 60 U. P. ... ... =2 samples;
At and below 60 U. P. but above 80 U. P. ... ... =9 samples;
Below 90 U. P. ... ... =1 sample.

The chief constituents of fusel oil (amyl and butyl alcohols) having higher boiling-points than ordinary alcohol or water tend to distil over principally towards the end of distillation, *i.e.*, with the weak "tailings."

"Fusel oil".

It will be seen from the above that Country spirits compare very favourably with Imported and Indo-European spirits as regards the proportions of fusel oil present.

We may take 400 parts of "fusel oil" per 100,000 as an ordinary figure for high class spirits and reference to the analytical results will show that some of the finest qualities of brandy analysed exceed this amount.

96 per cent. of Country spirits contain *less than* 400 parts per 100,000 as against 98 per cent. of imported and 97 per cent. of Indo-European spirits. In the higher proportions present, the percentages closely approximate.†

"ETHERS" (COMPOUND ETHERS OR ESTERS).

Classification in groups according to increasing ether-content.

Milligrams per 100 c. c. of absolute alcohol (parts per 100,000 approximately).	Country spirits.		Imported spirits.		Indo-European spirits.	
	No.	Per cent.	No.	Per cent.	No.	Per cent.
Up to 100 per 100,000 (100= ·26 gram per quart) ...	113	32	50	59	25	66
100—200 per 100,000 (200= ·52 gram per quart) ...	109	31	18	21	11	29
200—300 per 100,000 (300= ·78 gram per quart) ...	64	18	9	11	2	5
300—400 per 100,000 (400=1·04 gram per quart) ...	30	8	1	1	...	...
400—500 per 100,000 (500=1·30 gram per quart) ...	18	5	4	5	...	...
500—600 per 100,000 (600=1·56 gram per quart) ...	7	2	2	3	...	...
Above 600 per 100,000	13	4	...	...	...	...
Total spirits analysed= ...	354	100	84	100	38	100

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† See note on composition of "fusel-oils" in remarks on Volatile Oils.

Ethers.

This group of by-products is regarded as the most harmless and most desirable of all others from the point of flavour. The comparison between the three classes of spirits is satisfactory. The high amounts found in certain Country Spirits is believed to be to some extent directly associated with the high acidity present, the acid combining with the alcohol to form these "Ethers." (My previous remarks show the necessity for caution in coming to any final conclusions as to this latter action until the subject has been thoroughly worked out on an extended scale).

ALKALOIDAL BASES.

Alkaloidal Bases.

A large number of spirits of all three classes (Country, Imported and Indo-European) have been examined for these substances which have been alleged to be occasionally naturally present in spirits or (in India) to be added to them—*e.g.*, *nux vomica*, aconite, dhatura, tobacco, hemp, etc., but in no case has even the faintest trace of any such bodies been revealed by the very delicate analytical method employed. Furthermore, the feints, ethers, etc., from the feints' and ether-receivers of the Nellikuppam and Rosa patent stills, as well as the foreshots from the latter distillery, showed no trace of these substances. It is chiefly in beet-spirits that alkaloidal bases have been hitherto detected, but it has been alleged that they are often present in spirits and that much of the deleterious action of spirits is due to them. My analyses, however, show that these bodies are apparently of very rare occurrence.

On the other hand, it is chiefly if not entirely in connection with retail vend that the addition of alkaloids to (generally weak) spirits is alleged to be made in order to increase their action. Most of my samples have come direct from distilleries so that adulteration with such substances was hardly to be expected. But my experience as Chemical Examiner for Bengal and Assam (and formerly for the Punjab) shows that the addition of alkaloidal drugs to spirits is much rarer than has been supposed in these Provinces.

This subject is further dealt with in Chapter XIV.

VOLATILE OILS.

These may be present

(*a*) naturally or may be

(*b*) added by the manufacturer to flavour the spirits.

As regards the natural oils occurring in spirits their proportions are so minute that their presence is more a matter of academic than of practical interest. I have endeavoured to separate a volatile oil from mahua spirit:—

I. *Mahua spirit* (pot-still).—6 litres were examined in order to isolate the oil or other principle which gives the characteristic odour to *mahua*. A very small amount of a whitish waxy solid was obtained (after prolonged fractionation and other treatment) which possessed the characteristic *mahua* odour and which appeared to be identical with the product also obtained by us in minute amounts by extraction of the dried *mahua* flowers by various means. The amount of odoriferous principle present in *mahua* spirits appears, therefore, to be extremely small; and it further was found to possess no physiological action when given to dogs. This was the chief point of interest for our present purpose, and there seemed no practical advantage to be gained from further research work as regards the exact chemical composition, &c., of the substance, even had time permitted of such.

There was also incidentally found a very close correspondence between the amount of amyl alcohol got by fractionation and the quantity of "fusel oil" as shown by Allen-Marquardt's process.

Other examples of fusel-analysis from *mahua*, cane, and rice spirits follow:—

II. *Mahua pot-still spirit.*—1 litre of spirit (70 U. P.) gave:—

		Found by fractionation.	Ordinary analysis.
Ethyl alcohol	...	162 c. c. of 100%	166 c. c.
Amyl alcohol	...	About 0·5 c. c.	
		= 0·41 gram	0·30 gram.

No "oil" was found; or intermediate alcohols.

III. *Cane-sugar patent-still spirits.*—1 litre of "feints" from the "feints-receiver" at Rosa gave:—

Ethyl alcohol		310·0 c. c. of 100% alcohol.
Amyl alcohol		260·0 c. c.
Intermediate alcohols—		
Ethyl + (?) Isopropyl	3·0 c. c.	8·0 c. c.
Normal-propyl	4·0 c. c.	
Isobutyl	1·0 c. c.	
Products boiling higher than amyl but not quite free from it		4·0 c. c.
Water (also acid and ethers)		=418·0 c. c.
		1,000 c. c.

Thus the amount of amyl alcohol present was 30 times as great as the combined amount of all the other alcohols, except ethyl.

As expected, no "oils" were found.

IV. *Rice* (outstill) *spirit.*—1 litre of the spirit gave:—

	Found by fractionation.	Ordinary analysis shewed.
Ethyl alcohol	353 c. c. of 100%	363 c. c.
Amyl alcohol	About 1 c. c.	
	= 0·82 gram	0·88 gram.

No "oils" or intermediate alcohols were isolated.

It will be seen that the results obtained as regards the composition of the "fusel oils" indicate an overwhelming preponderance of amyl over other higher alcohols. The fusel obtained from "feints-receivers" is, however, to be considered apart from the results obtained by fractionation of the spirits themselves. For the "feints receiver" specially retains amyl alcohol while the lower-boiling butyl and propyl alcohols escape separation in greater measure. The examination of the pot-still spirits, however, indicates the extent to which amyl predominates. This is fortunate for I find that Allen-Marquardt's process is specially accurate with amyl alcohol rather than with the butyls and propyls.

Volatile oils.

As regards the volatile or essential oils *added* to spirits in order to artificially flavour them the quantitative estimation of them would have further considerably prolonged the investigation. I decided, therefore, to defer the examination of spirits for volatile oils until such time as I had proved these substances to be of a noxious nature in the amounts in which we know they are added to spirits. On physiological investigation, the oils were found to be quite unimportant and so analysis of spirits for volatile oils has not been considered necessary.

CONCLUSIONS FROM THE ANALYSIS OF SPIRITS.

As regards "fusel oil", aldehydes and ethers, country spirits compare quite favourably with the relatively high-priced Imported spirits obtained from the most dependable sources, as also with Indo-European spirits.

On the other hand, Country Spirits compare badly with Imported and Indo-European Spirits as regards the proportions present in the former of furfural and of acids. It has, however, been already pointed out that the removal of both these defects is merely a question of improved manufacture and supervision and the practical means of accomplishing this are described in later Sections of this Report.

Cheap Imported Spirits.

Cheap Imported Spirits.—These are now dealt with separately as forming a subject for consideration apart from Country and Indo-European spirits.

The descriptions and prices of Cheap Imported spirits analysed are here given:—

	Descriptions on the labels of the bottles.	Place of origin.	Price per reputed quart.		
			Rs.	A.	P.
	Madras.				
1.	Eau-de-Vie vieille: vieux Cognac, 3 stars	Germany	1	0	0
2.	Fine Champagne Cognac	France	1	2	0
3.	Old Tom Gin, superior quality	Germany	1	0	0
4.	Fine Old Pale Brandy	„	1	0	0
5.	Superior Old Brandy, 3 stars	„	1	2	0
6.	Old Champagne, best quality	„	1	0	0
	Bombay.				
7.	Rectified Spirit, 60·4° O. P.	Unknown	2	1	6
8.	No. 2 Rum	„	0	15	0
9.	Fine Flavoured. The Old Vatted Scotch Whiskey	„	1	2	0
10.	Eau-de-Vie (wired bottle)	Bordeaux, France.	1	0	0
11.	Cognac, 4 stars (wired bottle)	France	1	6	0
12.	Cognac, 3 stars „ „	„	1	0	0
13.	Eau-de-Vie „ „	Bordeaux, France.	1	0	0
14.	2 stars Fine quality Pale Brandy	Unknown	0	15	0
	Calcutta.				
15.	Superior Old Brandy	Germany	0	13	6
16.	Brandy	„	0	11	0
17.	No. 1 Brandy	„	0	12	0
18.	Fine Old Blended with Scotch Whiskey	„	0	11	0
19.	No. 1 Brandy	„	0	12	0
20.	Do.	„	0	11	0
21.	Do.	„	0	14	0
22.	Jamaica Rum	Jamaica	0	12	0
23.	Do.	„	0	12	0
24.	Blend Scotch Whiskey	Germany	0	11	0
25.	Blended with pure Scotch Whiskey	„	0	11	0
26.	Blended with Scotch Whiskey	„	0	12	0
27.	No. 1 Brandy	„	0	12	0

(The names of the manufacturing and retailing firms concerned are forwarded in a separate confidential statement).

Twenty-seven samples were sent for analysis at the instance of the Excise Committee—six from Madras; eight from Bombay; and thirteen from Calcutta.

Acidity.—Was low in every case (under 100 parts per 100,000 of absolute alcohol).

Aldehydes.—59 per cent. had no trace of these; 10 per cent. had under 25 parts per 100,000; and in one sample the amount was 50·2 per 100,000—a moderate amount in every case where present.

Furfural.—90 per cent. had none or slight traces of this by-product, and of the remaining three samples two had only 1·2 parts per 100,000 and the third even less.

The above figures serve to indicate the patent-still origin of these spirits.

Fusel Oil.—41 per cent. had under 100 parts per 100,000; 22 per cent. had between 100 and 200 parts; 18 per cent. had from 200 to 400 parts; and 19 per cent. above 400 parts. The samples from Madras and Bombay were all below 200 parts per 100,000. The only samples above 200 parts were eleven from Calcutta, nine of which were declared to be of German origin, and two were described as rums imported from Jamaica.

Ethers.—44 per cent. had under 100 parts per 100,000 of absolute alcohol; 33 per cent. had between 100 and 200 parts; 19 per cent. had between 200 and 300 parts; and 4 per cent. had between 400 and 500 parts. These figures call for no special comment.

Obscurations.—The obscuration in all the samples of Calcutta cheap spirits is much higher than that found in imported spirits of ordinary quality or in the Madras and Bombay cheap imported spirits.

The following table shows this:—

Up to 1 per cent.	4 samples.	
1 to 3 per cent.	2 ,,	
3 to 5 per cent.	4 ,,	
5 to 7 per cent.	4 ,,	
Between 10 and 27 per cent.	13 ,,	all from Calcutta.

As regards alcoholic strength.—These 27 samples showed the following results:—

Over-proof (rectified spirit)	60·4° O. P.	1 sample.
Alcoholic strength of Cheap Imported spirits.	13 to 15° U. P. ...	1 ,,
	40 to 50° ,, ...	10 samples.
	50 to 60° ,, ...	4 ,,
	60 to 70° ,, ...	9 ,,
	70 to 80° ,, ...	2 ,,
	Total ...	27 ,,

Thus, 25 samples out of the 27 were below 40° U. P., 15 were below 50° U. P. and 11 below 60° U. P.

The 84 samples of imported spirits of ordinary quality (whiskey, gin, brandy and rum) which I have analysed gave the following results:—

10° U. P. and above	5 samples.
10 to 20° U. P.	69 ,,
20 to 25° ,, ...	10 ,,
Total ...	84 ,,

So that all of these were above 25° U. P., while of the cheap imported spirits two only were over this strength, and one of these two was an industrial spirit and so may be excluded.

In 1901 I reported to the Bengal Excise Commissioner on the subject of certain cheap imported spirits obtained in Calcutta; and in 1902, I also reported, demi-officially, on this subject to the Finance Member of Council (Sir Edward Law). The samples analysed were collected by the Excise Department in the Calcutta bazaars, and I compared them with a number of samples of good ordinary quality. Several different samples of so-called "Scotch Whiskey" labelled "Produce of Germany, blended with Scotch Whiskey" and "Blended with Scotch specially selected, very old," and several of "Brandy" (labelled "Champagne Cognac") were analysed by me, and in every case these presented all the characteristics of patent-still spirit chiefly flavoured with essences of whiskey, gin and brandy. Here, again, no sample was stronger than 42° U. P. Several samples of German (chiefly from Hamburg) silent spirit (averaging 66° O. P.) examined at the same time proved to be very badly rectified and to contain relatively large proportions of by-products.

Usual nature of these spirits.

Cheap imported spirits are thus seen to consist largely of patent-still spirits chiefly flavoured with essences of brandy, whiskey, gin and rum, but diluted much below the recognised strengths of the spirits they are designed to imitate. Some of the Calcutta samples (mostly German) are badly made and some would appear to be steering rather close to a false trade description, *e.g.*, " specially selected, very old, blended with Scotch whiskey," etc.*

The subject of Cheap Imported spirits is dealt with at greater length in a later Chapter.

From the point of noxiousness, there appears to be no objection to be taken to the Bombay or Madras cheap imported spirits. They contain very moderate proportions of by-products and are of weak alcoholic strength. It might, therefore, be fairly argued that they are less likely to be injurious to health than a corresponding amount of the higher grades of imported spirits. No minimum limit of alcoholic strength for imported spirits has been fixed in India, and it is very questionable whether it would be advisable to do so. The weaker such spirits are the less noxious, bulk for bulk, would they appear to be (given also low proportions of by-products).

The Calcutta cheap samples are in a somewhat different category to those from Bombay and Madras on account of their high fusel-content. It has been seen that the Calcutta samples yield all the (relatively) high fusel figures, but that their acidity, aldehydes and furfural are all low. This points to (*a*) either imperfect rectification and consequent defective removal of fusel; or more probably (*b*) to the addition of fusel feints or (*c*) of flavouring essences too strong in fusel oil. But after all, the fusel-proportion is not a serious matter, more particularly if we compare it with that of many high-class spirits.

Indian spiced Liquors.

Indian Spiced Liquors.—These liquors also may be conveniently considered as forming a class by themselves being Country or Indo-European spirits artificially flavoured and in certain cases highly sweetened, and therefore somewhat resembling " liqueurs " or " cordials ".

I. *Karnal Distillery spiced samples*—eight in number.

Alcoholic strength—varies from 14·6 U.P. to 23·5 U.P.

Acidity—	from 92 to 241·9	parts per 100,000 alcohol.
Furfural	1·2 to 4·2	,,
Aldehydes	11·3 to 26·6	,,
Fusel oil	125·4 to 329·1	,,
Ethers	82·5 to 277·3	,,
Sugar	absent in all	
Obscuration	from 0·2 to 8·4%.	

They are variously flavoured and scented, *unsweetened*, relatively alcoholically strong, and as regards by-products unobjectionable spirits.

II.—*Uran spiced Liquors*—8 samples.

Alcoholic strength—from 30·5 to 33.1 U.P.

Acidity—from	38·9 to 157·0	parts per 100,000 alcohol.
Furfural	3·0 to 8·0	,,
Aldehydes	14·8 to 21·3	,,
Fusel oil	122·4 to 181·9	,,
Ethers	79·4 to 410·1	,,

Sugar—Very large amounts present in each case.

Obscuration—71·5 to 87%.

These samples are thus seen to have the same characteristics as the Karnal samples except for their very large obscurations, chiefly due to heavy sugaring.

III.—*Kotri spiced Liquors*†—13 samples.

Alcoholic strength—from 2·6 U.P. to 35·2 U.P.

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* NOTE.—A list of the firms from which the samples herein reported on were obtained is sent separately under a " confidential " cover.

† The sugars could not be estimated in these samples as the samples had already been expended in the course of the previous analyses for by-products, etc., and there was no time left in which to procure fresh samples.

Acidity—from 39·7 to 183·2 parts per 100,000 alcohol.
Furfural 0·7 to 4·0 ,,
Aldehydes Nil to 27·6 ,,
Fusel oil 34·9 to 205·7 ,,
Ethers 3·2 to 259·5 ,,
Obscuration Nil to 2·8%

IV. *17 other spiced samples*—from Surat, Ahmedabad, Gonda, Sholapur, Bahraich, Bareilly, Dharwar and Deoghar.

Alcoholic strength—from 19·0 U.P. to 27·4 U.P.
Acidity—from 30·2 to 957·3 parts per 100,000 alcohol.
Furfural 1·4 to 20·7 ,,
Aldehydes 5·0 to 54·7 ,,
Fusel oil 24·8 to 372·5 ,,
Ethers 32·2 to 538·6 ,,
Obscuration—Nil to 3·6%
Sugars—Absent in all.

Much the same conclusions apply in groups III and IV as in the case of I, except that in group IV four samples had very high acidities—above 250 parts per 100,000—and ten samples had too high furfural contents. I have also analysed, for purposes of comparison, a sample of Russian Kummel and of French Vermouth (from the best makers) and the results (in parts per 100,000) are as follows :—

Alcoholic strength.	Acidity.	Aldehydes and Furfural.	Fusel oil.	Ethers.	Total sugars in grams per litre.
Russian Kummel 24·0 U.P.	20.7	*Nil*	409.6	30·4	195·4*
French Vermouth 65·2 ,, ...	2442·2	*Nil*	411·0	132·6	53·2†

* Cane sugar (as glucose).

† Total made up thus : Invert sugar (as glucose) 52·3; Cane sugar (as glucose) 0·9 grams per litre.

The acidity-estimation in the case of the Vermouth sample was twice repeated with a like result ; and another sample was again examined for acidity some months later. This latter gave a total acidity of 2,648 parts per 100,000 (the volatile acidity being 183·7 and the fixed acidity 2,463·3); and the alcoholic strength was 65·7 U.P. The enormous fixed acidity (tartaric acid) points to the Vermouth having a vinous rather than a spirituous basis. Such a large acidity is very undesirable from the point of view of wholesomeness.

If Vermouth were consumed in the same relative daily amounts as country spirits we should be likely to hear complaints as to its causing digestive and other troubles. If we compare this Vermouth (procured from one of the best known firms for its manufacture) with most of the Indian spiced liquors the comparison is in favour of the latter as regards wholesomeness.

There may here also be usefully contrasted with the Indian-made, distilled, spiced liquors a few samples of Imported Cordials and also of those compounded from probably imported silent spirit by firms in Calcutta. These were described as " Rose liqueur " and " Creme de Rose ", and were coloured red, flavoured and scented.

They had alcoholic strengths varying from 82·6 to 68·6 U.P.;
Acidities from nil to 30·3 parts per 100,000 ;
Aldehydes ,, traces to 12·1 ,,

Furfural : nil in every case ;
" Fusel oil " from 165·8 to 773·7 parts per 100,000 ;
Ethers „ Nil to 36·8 „
Sugars „ 29·40 to 52·74 grams per 100 c.c. of liquor ;
(Tannin, nil)
Total solids from 30·77 to 63·36 „

Their low proportions of acids, furfural and aldehydes and of ethers seem to point to their patent-still origin. They are all alcoholically weak ; heavily sugared and treated with flavouring essences and colouring matter. They thus seem to have no special deleteriousness and compare favourably with uncompounded spirits of like origin. Other considerations connected with the subject of spiced liquors will be dealt with in later Chapters.

FERMENTED LIQUORS.

Fermented Liquors.

These have been classed as follows :—

(1) Imported beers (examined chiefly for comparative purposes).
(2) Beers brewed in the Hills in India.
(3) Beers brewed in the Plains in India.
(4) Miscellaneous native Fermented Liquors, *e.g.*, *mahua* beer, *soma*, etc.
(5) Rice beers (*pachwai*, etc.)
(6) Different varieties of Toddy (fermented palm-sap).

Grouping followed.

With regard to fermented liquors the grouping followed is according to the same amounts of by-products per quart* as in the spirit-tabulations but the quart here is not at 60 U.P. (as in spirits) *but at the average natural strength of the fermented liquor concerned.* This modification has been necessitated by the fact that the fermented liquors' natural alcoholic range is from 85—95 U.P. and it has seemed undesirable to calculate them up to the higher artificial strength of 60 U.P. as for spirits. The general result is to show that the by-products in Indian fermented liquors—except furfural which is usually absent—have much the same range as to amount as those in spirits at 60 U.P.; *i.e.*, *bulk for bulk*, or comparing 1 quart of fermented liquor at its average alcoholic strength with 1 quart of spirit at 60 U.P.

COMPARISON OF ACIDITY :

In fermented liquors and spirits, as regards percentage of samples found to contain certain specified amounts of acid per quart.

Basis of classification : Equal volumes of spirit at 60 U. P. and of fermented liquor at natural strength.

	SPIRITS.			BEERS, ETC.					
——	Country.	Imported.	Indo-European.	Imported.	Indian Hills.	Indian Plains.	Mohua, Soma, etc.	Pachwai rice, etc.	Toddies.
No. of samples analysed.	355	84	38	11	25	31	11	24	30
Amount of acid per quart in grammes.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Under ·26 ...	18	99	84	73	52	20	28	17	...
·26—·78 ...	37	1	8	27	48	74	18	42	13
·78—1·30 ...	22	...	5	...	...	6	9	33	27
1·30—2·08 ...	13	...	...	...	...	...	...	4	23
2·08—3·12 ...	6	...	3	...	...	...	18	4	14
2·12—5·20 ...	3	...	...	...	...	...	18	...	20
Above 5·20 ...	1	...	...	...	...	..	9	...	3
	100	100	100	100	100	100	100	100	100
Volume of fermented liquor alcoholically equivalent to 1 volume of 60 U. P. spirit.	1	1	1	3·9	3·2	3·0	3·3	3·0	5·4

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* The equivalent value in parts per 100,000 of alcohol differs numerically and has, therefore, not been given.

COMPARISON OF ALDEHYDES:

In fermented liquors and spirits, as regards percentage of samples found to contain certain specified amounts of aldehydes per quart.

Basis of classification: equal volumes of spirit at 60 U. P. and of fermented liquor at natural strength.

	SPIRITS.			BEERS, ETC.					
—	Country.	Imported.	Indo-European.	Imported.	Indian Hills.	Indian Plains.	Mahua, Soma, etc.	Pachwai, rice, etc.	Toddies.
No. of samples analysed.	355	84	38	11	25	31	11	24	30
Amount of aldehyde per quart in grammes.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
Nil.	8	1	8	36	28	55	91	58	87
Under ·065 ...	64	80	60	64	52	32	9	13	7
·065—·13 ...	24	12	29	...	20	13	...	4	...
·13—·26 ...	3	6	3	...	...	...	...	4	3
·26—·39 ...	0·3	1	...	...	...	...	..	4	3
Above ·39 ...	1	...	...	...	...	...	...	17	...
	100	100	100	100	100	100	100	100	100
Volume of fermented liquor alcoholically equivalent to 1 volume of 60 U. P. spirit.	1	1	1	3·9	3·2	3·0	3·3	3·0	5·4

COMPARISON OF FURFURAL:

In fermented liquors and spirits as regards percentage of samples found to contain certain specified amounts of Furfural per quart.

Basis of classification:—Equal volumes of spirit at 60 U. P. and of fermented liquor at natural strength.

	SPIRITS.			BEER, ETC.					
—	Country.	Imported.	Indo-European.	Imported.	Indian Hills.	Indian Plains.	Mahua, Soma, etc.	Pachwai rice, etc.	Toddies.
No. of samples analysed.	355	84	38	11	25	31	11	24	30
Amount of furfural per quart in grammes.	per cent.	per cent.	per cent	per cent.	per cent.	per cent	per cent.	per cent.	per cent.
Under ·0026 ...	11	33	47	100	100	97	100	100	100
·0026—·0078 ...	19	46	21	...	...	3	...	...	...
·0078—·0156 ...	23	15	16	...	...	...	...	...	...
·0156—·0260 ...	24	5	10	...	...	...	...	...	...
·0260—·0520 ...	20	...	3	...	...	...	...	...	...
·0520—·0780 ...	2	1	...	...	...	...	...	...	...
·0780—·1400 ...	1	...	...	...	...	...	...	...	...
Above ·1400 ..	...	...	3	...	...	...	...	...	...
	100	100	100	100	100	100	100	100	100
Volume of fermented liquor alcoholically equivalent to 1 volume of 60 U. P. spirit.	1	1	1	3·9	3·2	3·0	3·3	3·0	5·4

COMPARISON OF "FUSEL OIL:"

In fermented liquors and spirits as regards percentage of samples found to contain certain specified amounts of Fusel oil per quart.

Basis of calculation—Equal volumes of spirit at 60 U. P. and of fermented liquor at natural strength.

	Spirits.			Beers, etc.					
—	Country.	Imported.	Indo European.	Imported.	Indian Hills.	Indian Plains.	Mahua Soma, etc.	Pachwai, rice, etc.	Toddies.
No. of samples analysed	354	84	38	11	25	31	11	24	30
Amount of Fusel per quart in grammes	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
Under 0·26 ...	26	25	29	45	28	29	18	25	33
0·26—0·52 ...	42	55	47	18	56	56	...	4	44
0·52—0·78 ...	19	14	13	28	16	6	...	33	13
0·78—1·04 ...	8	5	8	...	...	6	55	25	3
Above 1·04 ...	5	1	3	9	...	3	27	13	7
	100	100	100	100	100	100	100	100	100
Volume of fermented liquor alcoholically equivalent to 1 volume of 60 U. P. spirit ...	1	1	1	3·9	3·2	3·0	3·3	3·0	5·4

COMPARISON OF ETHERS:

In fermented liquors and spirits, as regards percentage of samples found to contain certain specified amounts of Ethers per quart.

Basis of classification—Equal volumes of spirit at 60 U P. and of fermented liquor at natural strength.

	Spirits.			Beers, etc.					
—	Country.	Imported.	Indo European.	Imported.	Indian Hills.	Indian Plains.	Mahua Soma, etc.	Pachwai, rice, etc.	Toddies.
No. of samples analysed ...	354	84	38	11	25	31	11	24	30
Amount of ethers per quart in grammes	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
Under ·26 ...	33	61	63	100	92	97	73	42	27
·26—·52 ...	30	21	32	..	4	3	9	37	30
·52—·78 ...	17	9	5	...	...	*Nil*	9	13	20
·78—1·04 ...	9	1	...	...	...	*Nil*	...	4	7
1·04—1·30 ...	5	5	...	...	...	*Nil*	...	4	6
1·04—1·56 ...	2	3	...	...	...	*Nil*	...	...	3
Above 1·56 ...	4	...	...	...	4	*Nil*	9	...	7*
	100	100	100	100	100	100	100	100	100
Volume of fermented liquor alcoholically equivalent to 1 volume of 60 U. P. spirit ...	1	1	1	3·9	3·2	3·0	3·3	3·0	5·4

*Two very high.

Relative bulks consumed of fermented liquors and of spirits.

A much larger bulk of fermented liquor than of spirits is consumed on an average and the local enquiries show that the ratio between these bulks (about 4 : 1) is such that, as a net result, about the same amount of absolute alcohol is consumed by the drinker of either class of liquor. In other words, had the by-products of the fermented liquors been arranged in groups *after calculating them to the basis of 1 quart of liquor at 60 U.P.* (that is, to the same amount of alcohol as in the spirits) the percentage arrangement would *practically* represent the relative amounts of by-products encountered in spirits and in fermented liquors by the respective drinkers of each.

By way of illustration this has been done for the acidity and fusel groups from which it is clear that the drinker of fermented liquor actually consumes *more* of these by-products than does the spirit drinker in his more concentrated form of alcohol.

PERCENTAGE GROUPING AS REGARDS ACIDITY.

Amount of acid per 9·1 ozs. of absolute alcohol (= 1 quart of 60 U. P. spirit.)	Country spirits.	BEERS, ETC.											
		Imported.		Indian Hills.		Indian Plains.		Miscellaneous.		Pachwai, rice, etc.		Toddies.	
	per cent.	*a.* per cent.	*b.* per cent.	*a* per cent.	*b.* per cent.	*a* per cent.	*b.* per cent.	*a.* per cent	*b.* per cent.	*a.* per cent.	*b.* per cent.	*a.* per cent.	*b.* per cent.
Under ·26 grams ...	18	73	...	52	*Nil*	20	*Nil*	28	*Nil*	17	13	*Nil*	...
·26—·78 " ...	37	27	45	48	44	74	20	18	18	42	4	13	...
·78—1·3 " ...	22	...	46	...	24	6	32	9	9	33	17	27	...
1·3—2·08 " ...	13	...	9	...	32	...	39	...	18	4	8	23	...
2·08—3·12 " ...	6	...	...	...	...	...	6	18	...	4	33	14	3
3·12—5·2 " ...	3	...	...	...	...	...	3	18	9	...	17	20	10
Above 5·2 " ...	1	...	...	...	...	...	*Nil*	9	46	...	8	3	87
	100	100	100	100	100	100	100	100	100	100	100	100	100

Columns (*a*) shew the percentage-grouping compared with spirit on the "bulk for bulk" basis.

Columns (*b*) shew the percentage-grouping compared with spirit, on the "alcoholic equivalent" basis (*i.e.*, 9·1 ounces of absolute alcohol which is the amount in 1 quart of 60 U. P. liquor).

Thus for illustration :—

The spirit drinker encounters only 1 per cent. of spirits in which the acidity exceeds 5·2 grams per quart of 60 U. P. (9·1 ounces of alcohol).

The drinker of the last three classes of fermented liquor encounters, on an average, 9 per cent., *nil* and 3 per cent. respectively of samples with over 5·2 grams of acid per quart; but if he takes the same amount of alcohol (9·1 ounces) as the spirit drinker then 46 per cent, 8 per cent and 87 per cent respectively of his liquors have an amount of acid exceeding 5·2 grams per 9·1 ounces of alcohol.

Percentage Grouping as regards "Fusel Oil".

Amount of fusel per 9·1 ozs of absolute alcohol =(1 quart 60 U. P. liquor) in grams.	Percentage of country spirits.	Beers, etc.											
		Imported.		Indian Hills.		Indian Plains.		Miscellaneous.		Pachwai rice, etc.		Toddies.	
		a. per cent.	*b* per cent.	*a* per cent.	*b.* per cent.	*a.* per cent.	*b.* per cent.	*a.* per cent.	*b.* per cent.	*a.* per cent.	*b* per cent.	*a.* per cent.	*b.* per cent.
Under ·26 ...	26	45	*Nil*	28	*Nil*	29	*Nil*	18	*Nil*	25	13	33	3
·26—·52 ...	42	18	18	56	20	56	10	*Nil*	*Nil*	4	8	44	*Nil*
·52—·78 ...	19	28	28	16	4	6	19	*Nil*	18	33	4	13	3
·78—1·04 ...	8	*Nil*	*Nil*	*Nil*	20	6	10	55	*Nil*	25	4	3	10
Above 1·04 ...	5	9	54	*Nil*	56	3	61	27	82	13	71	7	84
	100	100	100	100	100	100	100	100	100	100	100	100	100

a=percentage grouping on "bulk for bulk" basis.

b=percentage grouping on 'alcoholic equivalent" basis.

Illustration: The spirit-drinker encounters only 5 per cent. of spirits in which the fusel oil exceeds 1·04 grams per quart at 60 U. P. (9·1 ounces of absolute alcohol).

The drinker of fermented liquors on the bulk for bulk basis obtains in about 10 per cent. of the beers more than 1·04 gram of fusel per quart, but 50 to 80 per cent. of the samples yield this amount (over 1·04 grams) if the alcoholic equivalent is drunk: moreover the fusel is not merely slightly in excess of 1·04 grams but often twice or thrice that amount.

COMPARISON AS REGARDS BY-PRODUCTS OF THE VARIOUS CLASSES OF FERMENTED LIQUORS.

Acidity.—The classes of imported beers and of those made by European methods in India compare favourably with each other as regards acidity.

(Hills' and Plains' beers have been included under the term "Indo-European" for ready reference).

The native fermented liquors, as might be expected from the crudity of their manufacture, are in many cases exceedingly acid liquors. The contrast between them and those made by European methods is very significant. Some allowance must be made for increase of acidity during transit here, and it must also be borne in mind that the number of samples of certain classes of fermented liquors is somewhat small on which to base any conclusions.

Aldehydes.—The imported, the "Indo-European" and the miscellaneous classes have a marked advantage over rice beers and toddies as regards the large number in which the amount of aldehydes is very small or absent. Whilst the total amount present in Indo-European beers is practically unimportant, it is of interest to note that smaller quantities of aldehydes are found in beers made in the Plains than in the Hills while the opposite is the case with regard to acidity, thus showing the influence of a higher temperature in favouring acid-formation and escape of the very volatile aldehydes.

Furfural.—In most cases furfural was absent, as was to be expected under the circumstances of manufacture of fermented liquors generally.

Fusel Oil.—The amounts found are, on the whole, large and in general exceed those found in the different classes of spirits. The Hill beers contain less fusel oil than the Plains' beers, as might be expected, for high temperatures during fermentation are well-known to promote the formation of fusel oil. The native fermented liquors contain relatively much higher amounts than do Imported or Indo-European beers or any class of spirits.

Ethers.—In European and Indo-European beers the amounts are negligible. In native fermented liquors, and especially in the toddies, large amounts of ethers are present, possibly in consequence of the high acidities present.

The amounts, at the average strength of 92·6 U.P. in toddies, are quite comparable to those found in spirits at 60 U. P. So that a toddy-drinker takes about five times as much " Ethers " as the average spirit-drinker (alcoholic equivalent basis).

RELATIVE NUTRITIVE VALUES OF FERMENTED LIQUORS.

The following statement shows in grams per 100 c. c. (practically in percentages) :—

(*a*) the average quantity present of sugars and albuminoids ;

(*b*) the highest amount found in any case ;

(*c*) the lowest amount found in any case; and also the average alcoholic strength of each group in terms of proof and volume percentage.*

Serial No.	—	AVERAGE ALCOHOLIC STRENGTH.		AVERAGE AMOUNTS.		HIGHEST AMOUNTS.		LOWEST AMOUNTS.	
		Volume per cent.	U. P.*	Sugar.	Albuminoids.	Sugar.	Albuminoids.	Sugar.	Albuminoids.
1	Toddies ...	4·8	92·6	2·22	2·76	7·36	30·62	0·33	0·08
2	Rice Beers ...	7·7	87·0	1·35	0·65	19·2	0·75	*Nil.*	0·16
3	Hill Beers ...	7·0	87·7	0·91	0·58	3·05	1·31	0·24	*Nil.*
4	Miscellaneous ..	7·0	87·8	0·72	0.5	3·06	1·75	*Nil.*	0·09
5	Imported ...	5·9	89·7	0·43	0·7	1·00	1·75	*Nil.*	0·26
	Plains ..	7·6	86·6	0·64	0·41	2·35	1·31	*Nil.*	*Nil.*

It thus appears that (*a*) toddies have the *highest average content of sugars and of albuminoids;* and next come (*b*) rice beers (pachwai, etc.) ; then (*c*) hill beers made by European methods ; then (*d*) miscellaneous Indian fermented liquors (*mahua* beer, *soma*, etc.) ; (*e*) then Plains' beers and imported beers.

It is, however, scarcely feasible to make a comparison as regards these classes of fermented liquors with reference to alcoholic strength and nutritive value. *Toddies, on an average, have the lowest alcoholic strength and the highest nutritive value.*

The comparison cannot be usefully carried further as the differences in alcoholic strength and in the proportions of sugars and albuminoids are too small.

CHEAP PORT WINES.

Several samples of cheap port were sent to me by the Excise Committee but not a sufficient number on which to base any final conclusions. The samples I have examined at different times fall into two groups:

1. Spurious ports, *i.e.*, containing too high proportions of sugar and of tannin and giving other indications of having been compounded.

2. New or " young " genuine wines which are cheap because unmatured.

With regard to the first class which alone are of interest to us I have not carried out a sufficient number of analyses as yet on these (which, after all, seem to be of comparatively rare occurrence) to be able to make any recommendations as to them at this stage.

I also append at page 84 a series of analyses of *good quality wines of different varieties* for purposes of reference and comparison, where required. I have no observations to make on these further than to direct attention to the large acidities present in some cases ; the very high aldehyde-content in the case of the Claret (St. Estephe) ; the virtual absence of furfural in all ; the marked amounts of fusel and of ethers ; and the small amounts of sugars and tannins (where present).

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* *Footnote* :—The statement has been made in terms of proof at the request of the Excise Committee, and is retained for the convenience of those who are accustomed only to proof terms.

Appendix to Section B.

STATEMENT A.

RESULT OF ANALYSIS

OF

SPIRITS:

I.—Imported... { (*a*) Ordinary quality
(*b*) Cheap quality.

II.—Indo-European.

III.—Country Spirits.

NOTE.—The names of firms and distilleries from which the samples of spirits, beers, wines, etc., have been obtained are shown in a separate Confidential Statement.

I.—(*a*) IMPORTED SPIRITS—

Serial Nmber.	Names and strength.	Alcoholic Strength. Vol. per cent.			Acidity.		
		Apparent.	True.	Percentage Obscuration.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.
1	2	3	4	5	6	7	8
1	Dry Gin	43·6	45·3	3·7	0·208	45·9	18·3
2	Whiskey	49·5	50·5	2·0	0·359	71·1	28·4
3	Brandy (Cognac)	48·1	49·6	3·0	0·295	59·5	23·7
4	11 Years' Old Whiskey...	49·5	51·8	4·4	0·330	63·7	25·5
5	Best Jamaica Rum	48·4	49·2	1·6	0·563	114·4	45·7
6	Fine Cognac (1848)	43·9	45·5	3·5	0·153	33·6	13·4
7	Rare old Cognac	47·3	49·4	4·3	0·162	32·8	13·1
8	Three Stars Brandy	47·9	50·0	4·2	0·060	12·0	4·8
9	Imperial Brandy	47·9	50·4	4·9	0·030	6·0	2·4
10	Jamaica Rum	46·8	50·5	7·5	0·492	97·4	38·9
11	Pine Apple Rum	49·0	49·2	0·4	0·096	19·5	7·8
12	Old Tom Gin	46·5	49·4	5·9	0·072	14·6	5·8
13	Old Tom Gin	41·6	43·9	5·2	0·024	5·7	2·2
14	Gaelic Whiskey	47·2	48·0	1·7	0·096	20·1	8·0
15	Special Whiskey	44·2	47·1	6·1	0·234	49·7	19·8
16	Irish Whiskey	43·2	45·5	5·0	0·078	17·1	6·8
17	Finest Old Irish Whiskey	49·0	49·0	*Nil*	0·172	35·1	14·0
18	Pure Highland Malt Whiskey	49·2	50·1	1·8	0·229	47·0	18·7
19	Very old Brandy	44·1	45·2	2·4	0·300	66·4	26·4
20	Old Cognac Brandy	43·6	46·0	5·2	0·180	39·1	15·6
21	Old Jamaica Rum	52·1	52·6	0·9	0·540	102·6	41·0
22	Ditto	49·6	51·3	3·3	0·150	29·2	11·6
23	Finest Highland Gin	51·9	52·8	1·7	0·330	62·5	25·0
24	Dry Old Tom	45·3	45·3	*Nil*	0·240	53·0	21·2
25	Finest old Scotch Malt Whiskey	50·9	52·0	2·1	0·420	80·8	32·2
26	Finest Old Scotch Whiskey, Blended ...	51·6	53·2	3·0	0·180	33·8	13·5
27	Blended very fine Irish Whiskey	47·1	50·0	5·8	0·180	36·0	14·4
28	Very fine Irish Malt Whiskey	52·0	52·4	0·8	0·030	5·7	2·3
29	Special Whiskey	59·1	60·0	1·5	0·450	75·0	30·0
30	Cognac Old Pale Brandy	48·4	51·6	6·2	0·330	63·9	25·5
31	London Fine Highland Malt Whiskey ...	49·1	49·6	1·0	0·090	18·1	7·2
32	Finest very old Scotch Whiskey	49·7	50·0	0·6	0·240	48·0	19·2
33	Whiskey (11 years' old)	48·4	49·6	2·4	0·240	48·4	19·4
34	Glenlivet Malt finest Old Highland Whiskey ...	48·8	50·4	3·1	0·300	59·5	23·8
35	Dublin Whiskey	48·8	49·8	2·0	0·180	36·1	14·4
36	Special Liqueur Scotch Whiskey	49·8	51·8	3·6	0·120	23·1	9·2

Abbreviations used.
U. T. or un-Tr. = Unreadable Trace.
V. s. t. = Very Slight Trace.
Tr. = Trace.

ALDEHYDES.			FURFURAL.			FUSEL OIL AS AMYL ALCOHOL.			ETHERS.			
Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Serial Number.
9	10	11	12	13	14	15	16	17	18	19	20	
ORDINARY QUALITY.												
0·133	29·3	11·7	0·001	0·2	0·09	0·505	111·5	44·5	0·106	23·4	9·3	1
0·062	12·3	4·9	0·009	1·8	0·7	1·090	215·8	86·1	0·352	70·0	27·8	2
0·250	50·4	20·1	0·014	2·9	1·1	2·251	453·9	181·1	0·581	117·1	46·8	3
0·086	16·6	6·6	0·010	2·0	0·8	0·730	140·9	56·4	1·276	246·3	98·6	4
0·270	55·9	22·3	0·049	10·0	4·0	0·581	118·1	47·2	1·126	228·9	91·3	5
0·398	87·5	35·0	0·005	1·0	0·4	1·786	392·5	156·9	0·475	104·4	41·7	6
0·082	16·6	6·6	0·005	1·0	0·4	0·190	38·5	15·4	0·334	67·6	27·0	7
0·061	12·2	4·9	0·005	1·0	0·4	0·198	39·3	15·8	0·150	30·0	12·0	8
0·090	17·9	7·1	0·004	0·8	0·3	0·068	13·5	5·4	0·229	45·4	18·2	9
0·083	16·4	6·6	0·026	5·5	2·2	0·038	7·5	3·0	2·385	472·3	188·4	10
0·051	10·4	4·1	0·008	1·6	0·6	0·684	139·1	55·6	0·211	43·0	17·1	11
Nil	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	0·334	67·0	27·0	0·475	96·1	38·4	12
0·034	7·7	3·1	*Nil*	*Nil*	*Nil*	0·272	62·0	24·7	0·035	8·0	3·2	13
0·153	32·0	12·8	0·014	3·0	1·2	0·470	98·3	39·3	0·299	62·6	25·0	14
0·104	22·1	8·8	0·011	2·3	0·9	0·144	30·6	12·2	0·704	149·4	60·0	15
0·058	12·7	5·1	0·013	3·0	1·1	0·608	133·6	53·3	0·352	77·4	30·9	16
0·076	15·5	6·2	0·013	2·7	1·1	0·646	131·8	52·7	0·475	97·0	38·8	17
0·080	16·3	6·5	0·017	3·5	1·4	0·370	75·5	30·2	0·528	107·8	43·2	18
0·117	25·9	10·3	0·010	2·2	0·9	0·581	128·5	51·2	0·396	87·6	35·0	19
0·071	15·4	6·2	0·006	1·3	0·5	0·352	76·5	30·6	0·352	76·5	30·6	20
0·063	12·0	4·8	0·009	1·7	0·7	0·290	55·1	22·0	1·716	326·2	130·3	21
0·101	19·7	7·9	0·013	2·5	1·0	1·646	320·8	128·0	0·396	77·2	30·8	22
0·049	9·3	3·7	0·023	4·4	1·7	1·214	230·0	91·9	0·220	41·7	16·6	23
0·028	6·2	2·5	*Nil*	*Nil*	*Nil*	0·651	143·7	57·4	0·220	48·6	19·4	24
0·139	26·7	10·6	0·021	4·0	1·6	1·126	216·5	86·4	0·396	76·2	30·4	25
0·096	18·0	7·2	0·012	2·3	0·9	0·361	67·8	27·0	0·880	165·4	65·9	26
0·089	17·8	7·1	0·009	1·8	0·7	0·387	77·4	31·0	0·440	88·0	35·2	27
0·092	17·5	7·0	0·037	7·0	2·8	0·546	104·2	41·6	0·520	99·2	39·6	28
0·122	20·3	7·2	0·032	5·3	2·1	1·188	198·0	79·0	1·276	212·7	83·9	29
0·082	15·8	6·3	0·010	1·9	0·7	0·695	134·6	54·0	0·484	93·8	37·5	30
0·055	11·1	4·4	0·006	1·2	0·5	0·607	122·4	48·9	0·308	62·1	24·8	31
0·110	22·0	8·8	0·009	1·8	0·7	0·933	186·6	74·5	0·748	149·6	59·8	32
0·157	31·7	12·6	0·009	1·8	0·7	0·994	200·4	80·2	1·144	230·7	92·3	33
0·110	21·8	8·7	0·012	2·4	0·9	0·528	104·7	41·9	0·924	183·3	73·3	34
0·094	18·8	7·5	0·015	3·0	1·2	0·827	166·1	66·4	0·572	114·9	45·9	35
0·077	14·8	5·9	0·007	1·4	0·5	0·704	135·9	54·4	0·440	84·9	33·9	36

Serial Number.	Names and strength.	Alcoholic Strength. Vol. per cent.			Acidity.		
		Apparent.	True.	Percentage Obscuration.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.
1	2	3	4	5	6	7	8
37	Very Old Scotch Whiskey	50·8	52·4	3·0	0·360	68·7	27·4
38	Old Vatted Glenlivet Whiskey (Special Reserve).	48·6	49·4	1·6	0·210	42·5	16·9
39	Pot—Still Whiskey	46·7	48·4	3·5	0·210	43·4	17·3
40	Old Highland Whiskey	49·2	49·8	1·2	0·270	54·2	21·7
41	Fine Old Blend Scotch Whiskey	49·6	50·8	2·3	0·240	47·2	19·
42	Special Old Highland Whiskey	48·8	50·0	2·4	0·240	48·0	19·
43	Finest Scotch Whiskey for Diabetes ...	48·6	49·2	1·2	0·390	79·3	31·
44	Very Old Scotch Whiskey	47·9	49·6	3·4	0·210	42·3	17·
45	Fine Old Three Stars Irish Whiskey ...	49·6	51·0	2·7	0·120	23·5	9·
46	Spanish Superior Old Brandy (distilled from pure wine).	47·9	51·6	7·1	0·360	69·8	27·
47	Cognac Three Stars	48·4	51·2	5·5	1·470	287·1	114·
48	French One Star Pale Brandy	48·6	53·4	9·0	0·480	90·0	35·
49	French Three Stars Fine Old Cognac Brandy.	49·0	54·0	9·2	0·480	89·0	35·
50	One Star Cognac	49·0	53·0	7·5	0·390	73·6	29·
51	French Two Stars Old Pale Brandy ...	48·8	53·0	8·0	0·360	68·0	27·
52	French Cognac Brandy	49·4	53·8	8·1	0·480	89·2	35·
53	Three Stars Superior Old Cognac Brandy ...	50·2	52·3	4·0	0·300	57·3	22·
54	Two Stars Cognac	49·0	51·2	4·1	0·450	87·9	35·
55	Four Stars Superior Old Brandy	49·4	51·5	4·1	0·120	23·3	9·
56	Bordeaux No. I Brandy	49·0	51·6	4·9	0·060	11·6	4·
57	„ No. II „	49·5	51·0	2·9	0·060	11·7	4·
58	Holland Spirit Cordial, pure Schiedam Schnapps	46·0	47·8	3·7	0·060	12·6	5·
59	Holland Spirit Cordial, Schnapps, extra special quality.	49·7	51·0	2·5	0·150	29·4	11·
60	Holland Exquisite Geneva superior quality ...	43·1	44·0	2·0	0·060	13·6	5·
61	Genuine Holland Geneva	45·9	46·6	1·5	0·060	12·9	5·
62	Rotterdam Pinke Junever	42·9	44·8	4·2	0·240	53·5	21·
63	Fine Old Jamaica Rum	49·8	51·2	2·7	0·480	93·7	37·
64	English Rum, No. I	49·3	51·0	3·3	*il.*	*il.*	*Nil.*
65	Old Jamaica Rum	48·5	50·8	4·5	0·480	94·4	37·
66	Jamaica Rum	48·9	49·2	0·6	0·150	30·5	12·
67	Leith Jamaica Rum	49·3	51·4	4·0	0·510	99·2	39·
68	Plymouth Gin	46·7	47·0	0·6	0·090	19·1	7·
69	Edinburgh Liqueur Whiskey (Gold Label) ...	47·0	49·8	5·7	0·150	30·1	12·
70	Scotch Whiskey	49·3	50·4	2·2	0·090	17·8	7·
71	Five Years' Old Irish Whiskey	47·5	48·4	1·9	0·090	18·6	7
72	Scotch Malt Whiskey, 12 years' old ...	49·6	51·0	2·7	0·210	41·1	16

ALDEHYDES.			FURFURAL.			FUSEL OIL AS AMYL ALCOHOL.			ETHERS.			
Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Serial Number.
9	10	11	12	13	14	15	16	17	18	19	20	
0·092	17·5	7·0	0·011	2·1	0·8	0·968	184·7	73·7	0·704	134·4	53·6	37
0·079	15·9	6·4	0·004	0·9	0·3	0·854	172·9	69·1	0·572	115·8	46·3	38
0·101	20·9	8·3	0·004	0·8	0·3	1·250	258·3	103·2	0·616	127·3	50·8	39
0·125	25·1	10·0	0·011	2·2	0·9	0·757	152·0	60·8	0·520	104·4	41·7	40
0·078	15·4	6·1	0·003	0·6	0·2	0·493	97·0	38·7	0·484	95·3	38·1	41
0·062	12·4	5·0	0·003	0·6	0·2	0·484	96·4	38·7	0·616	123·2	49·2	42
0·126	25·6	10·3	0·010	2·0	0·8	0·537	109·2	43·7	0·520	105·7	42·3	43
0·080	16·1	6·5	*Nil.*	*Nil.*	*Nil.*	0·440	88·7	35·5	0·880	177·4	71·0	44
0·051	10·0	4·0	V. s. t.	V. s. t.	V. s. t.	0·581	113·9	45·6	0·352	69·0	27·6	45
0·155	30·0	12·0	V. s. t.	V. s. t.	V. s. t.	0·713	138·2	55·2	0·132	25·6	10·2	46
0·106	20·7	8·3	*Nil.*	*Nil.*	*Nil.*	0·845	165·0	66·0	0·176	34·4	13·7	47
0·168	31·5	12·6	0·004	0·7	0·3	2·235	418·5	167·3	1·584	296·6	118·5	48
0·097	18·0	7·2	Tr.	Tr.	Tr.	1·848	342·2	136·5	1·320	244·4	97·5	49
0·053	10·0	4·0	0·006	1·1	0·5	1·197	225·8	90·2	0·420	79·2	31·7	50
0·076	14·3	57·3	Tr.	Tr.	Tr.	1·232	232·5	92·8	1·540	290·6	116·0	51
0·030	5·6	2·2	*Nil.*	*Nil.*	*Nil.*	0·449	83·4	33·3	3·168	588·8	235·4	52
0·026	4·9	1·9	0·002	0·4	0·2	0·546	104·4	41·7	2·860	546·8	218·5	53
0·036	7·0	2·8	0·002	0·4	0·2	0·827	161·5	64·6	2·244	438·3	175·3	54
0·015	2·9	1·1	*Nil.*	*Nil.*	*Nil.*	0·502	97·4	38·9	1.056	205·0	81·8	55
0·018	3·5	1·4	0·002	0·4	0·2	0·660	127·9	51·1	0·264	51·1	20·4	56
0·265	51·9	20·8	0·001	0·2	0·1	0·924	181·1	72·4	0·308	60·4	24·1	57
0·048	10·0	4·0	0·024	5·0	2·0	1·144	239·3	95·6	0·880	184·1	73·5	58
0·039	7·6	3·0	0·022	4·3	1·7	1·118	219·2	87·7	0·308	60·4	24·1	59
0·034	7·7	3·1	0·021	4·7	1·9	0·880	200·0	79·9	0·176	40·0	15·9	60
0·042	9·0	3·6	0·026	5·6	2·2	0·739	158·6	63·4	0·264	56·6	22·6	61
0·040	8·9	3·6	0·016	3·5	1·4	0·414	92·4	37·0	0·308	68·7	27·5	62
0·124	24·2	9·7	0·024	4·7	1·9	0·801	156·4	62·6	2·112	412·4	165·0	63
0·020	3·8	1·5	0·006	1·2	0·5	0·247	48·4	19·3	0·044	8·6	3·4	64
0·078	15·3	6·1	0·010	1·9	0·8	0·528	103·9	41·5	0·880	173·2	69·2	65
0·071	14·4	5·8	0·003	0·6	0·2	0·493	100·2	40·1	0·660	134·1	53·6	66
0·067	13·0	5·2	0·009	1·7	0·7	0·704	136·9	54·7	1·408	273·9	109·5	67
0·021	4·5	1·8	*Nil.*	*Nil.*	*Nil.*	0·537	114·2	45·6	0·088	18·7	7·5	68
0·063	12·7	5·1	0·004	0·9	0·3	0·898	180·3	72·1	0·352	70·7	28·3	69
0·066	13·1	5·2	0·012	2·4	0·9	0·845	167·6	67·0	0·176	34·9	13·9	70
0·105	21·7	8·6	0·012	2·5	0·9	0·994	205·4	82·0	0·132	27·3	10·9	71
0·198	38·8	15·5	0·036	7·0	2·8	0·890	174·5	69·7	0·264	51·8	20·7	72

NOTE—V. S. T=Very slight trace,
Tr.=Trace.

Serial Number.	Names and Strength.	Alcoholic Strength. Vol. per cent.			Acidity.		
		Apparent.	True.	Percentage obscuration.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.
1	2	3	4	5	6	7	8
73	Irish Whiskey	49·3	50·2	1·8	0·120	23·9	9·5
74	Edinburgh special Liqueur Pure Highland Whiskey.	47·7	48·6	1·9	0·120	24·7	9·9
75	Scotch Whiskey	49·3	50·0	1·4	0·120	24·0	9·6
76	Edinburgh Scotch Whiskey	47·5	49·0	3·0	0·060	12·2	4·9
77	Old Highland Whiskey	47·7	50·0	4·6	0·060	12·0	4·8
78	Glasgow Highland Whiskey, Blended ...	49·2	50·6	2·8	0·060	11·8	4·7
79	Grand Old Malt	50·1	50·8	1·3	0·060	11·8	4·7
80	Scotch Whiskey	48·6	49·0	0·7	0·150	30·6	12·2
81	Edinburgh Liqueur Whiskey (White Label) ...	46·4	46·8	0·9	0·090	20·0	7·7
82	Scotch Whiskey	49·4	49·8	0·8	0·120	24·1	9·6
83	Old Highland Malt Special Scotch Whiskey ...	47·5	48·0	1·0	0·090	18·7	7·5
84	Three Stars Cognac	46·5	49·8	6·6	0·120	24·1	9·6
				(*b*) IMPORTED SPIRITS—			
85	Vieux Cognac	29·4	31·2	5·8	0·090	28·8	11·5
86	French Fine Champagne Cognac	31·2	31·2	*Nil.*	0·120	38·4	15·4
87	German Old Tom Gin	28·3	29·7	4·7	0·060	20·2	8·1
88	German Fine old Pale Brandy	29·8	31·4	5·4	0·090	28·6	11·4
89	Superior Old Brandy	27·7	29·2	5·1	0·030	10·3	4·1
90	German Old Champagne Cognac	30·4	32·4	6·2	0·030	9·3	3·9
91	Rectified Spirit of Wine	91·5	93·0	1·6	0·090	9·6	3·8
92	No. 2 Rum	33·1	34·2	3·2	0·030	8·8	3·5
93	Fine flavoured old Vatted Scotch Whiskey ...	33·4	33·4	*Nil.*	0·060	17·9	7·1
94	Eau-de-vie	31·1	32·3	3·7	0·030	9·3	3·7
95	French Four Stars Cognac	49·3	51·4	4·0	0·030	5·8	2·3
96	French Three Stars Cognac	30·2	30·8	1·9	0·015	4·8	1·9
97	Bordeaux, Eau-de-vie	31·2	31·4	0·6	*Nil.*	*Nil.*	*Nil.*
98	Fine Pale Brandy 2 stars	33·5	33·6	0·3	*Nil.*	*Nil.*	*Nil.*
99	Superior Old Brandy, Germany	21·1	27·1	22·2	0·060	22·1	8·8
100	German Brandy	16·1	20·4	21·1	0·030	14·7	5·9
101	German No. 1 Brandy...	18·0	24·7	27·1	0·030	12·1	4·9
102	Fine old Blended Scotch Whiskey (Germany)	19·7	22·2	11·3	0·030	13·5	5·4
103	No. 1 Brandy (Germany)	18·0	21·1	14·7	0·060	28·4	11 4
104	No. 1 Brandy (Germany)	17·2	21·4	20·0	0·030	14·0	5·6
105	German No. 1 Brandy	25·0	31·1	19·6	0·060	19·3	7·6
106	Finest Jamaica Rum	21·1	26·9	1·2	0·030	11·1	4·4
107	Jamaica Rum	23·3	25·9	10·0	*Nil.*	*Nil.*	*Nil.*
108	Blend Scotch Whiskey (Germany) ...	16·9	20·7	13·5	0·030	14·5	5·8

ALDEHYDES.			FURFURAL.			FUSEL OIL AS AMYL ALCOHOL.			ETHERS.			
Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Serial Number.
9	10	11	12	13	14	15	16	17	18	19	20	
0·116	23·1	9·2	0·022	4·4	1·7	1·003	199·8	79·7	0·220	43·8	17·5	73
0·071	14·6	5·8	0·008	1·6	0·6	0·915	188·2	75·2	0·176	36·2	14·4	74
0·091	18·2	7·2	0·015	3·0	1·2	1·047	209·4	83·7	0·308	61·6	24·6	75
0·094	19·2	7·7	0·009	1·8	0·7	0·704	143·7	57·4	0·264	53·9	21·5	76
0·078	15·6	6·2	0·011	2·2	0·9	0·686	137·2	54·9	0·220	44·0	17·6	77
0·050	9·8	3·9	0·004	0·8	0·3	0·581	114·8	45·9	0·176	34·7	13·9	78
0·062	12·2	4·9	0·007	1·4	0·5	0·950	187·0	74·7	0·352	69·3	27·6	79
0·058	12·0	4·7	0·009	2·0	0·07	0·898	183·3	73·3	0·352	72·0	28·7	80
0·048	10·3	4·1	0·004	0·9	0·03	1·206	257·7	103·0	2·024	450·0	172·8	81
0·118	23·7	9·5	0·017	3·4	1·3	0·642	128·9	51·5	0·352	70·7	28·2	82
0·063	13·1	5·2	0·007	1·5	0·6	0·466	97·1	38·8	0·264	55·0	22·0	83
0·069	13·9	5·5	0·004	0·8	0·3	0·986	197·9	79·1	0·440	88·4	35·3	84
CHEAP QUALITY.												
Tr.	Tr.	Tr.	*Nil*	*Nil*	*Nil*	0·141	45·2	18·1	0·660	211·5	84·6	85
Tr.	Tr.	Tr.	*Nil*	*Nil*	*Nil*	0·097	31·1	12·4	0·440	141·0	56·4	86
Tr.	Tr.	Tr.	S. tr.	S. tr.	S. tr.	0·176	59·2	23·7	0·088	29·6	11·8	87
Tr	Tr.	Tr.	*Nil*	*Nil*	*Nil*	0·141	44·9	17·9	0·572	182·1	72·8	88
Tr.	Tr.	Tr.	*Nil*	*Nil*	*Nil*	0·211	72·3	28·7	1·188	406·8	161·8	89
Tr.	Tr.	Tr.	*Nil*	*Nil*	*Nil*	0·202	62·3	24·8	0·846	261·1	104·0	90
U. r. t.	U. r. t.	U. r. t.	U. r. t.	U. r. t.	U. r. t.	0·403	43·3	17·3	0·132	14·2	5·6	91
0·017	4·9	1·9	0·003	0·9	0·3	0·484	141·5	56·6	*Nil*	*Nil*	*Nil*	92
0·042	12·6	5·0	0·004	1·2	0·5	0·572	171·2	68·4	*Nil*	*Nil*	*Nil*	93
0·056	17·3	6·9	*Nil*	*Nil*	*Nil*	0·396	122·6	48·9	0·044	13·6	5·4	94
0·091	17·7	7·0	*Nil*	*Nil*	*Nil*	0·352	68·5	27·4	*Nil*	*Nil*	*Nil*	95
0·016	5·2	2·1	*Nil*	*Nil*	*Nil*	0·299	97·0	38·7	0·132	42·8	17·1	96
0·023	7·3	2·9	*Nil*	*Nil*	*Nil*	0·598	190·4	76·0	0·088	28·0	11·2	97
0·014	4·1	1·7	0·004	1·2	0·5	0·528	157·1	62·7	0·088	26·2	10·4	98
V. s. t.	V. s. t.	V. s. t.	*Nil*	*Nil*	*Nil*	0·167	61·6	24·6	0·308	113·7	45·4	99
V. s. t.	V. s. t.	V. s. t.	V. s. t.	V. s. t.	V. s. t.	0·818	400·9	159·9	0·572	280·4	111·9	100
0·124	50·2	20·1	*Nil*	*Nil*	*Nil*	1·100	445·3	178·2	0·220	89·0	35·6	101
V. s. t.	V. s. t.	V. s. t.	*Nil*	*Nil*	*Nil*	0·554	249·5	99·7	0·352	158·5	63·3	102
V. s. t.	V. s. t.	V. s. t.	*Nil*	*Nil*	*Nil*	0·466	220·9	88·4	0·396	187·7	75·1	103
V. s. t.	V. s. t.	V. s. t.	*Nil*	*Nil*	*Nil*	0·458	214·0	85·5	0·520	242·9	97·0	104
Nil	*Nil*	*Nil*	V. s. t.	V. s. t.	V. s. t.	0·774	248·9	98·7	0·572	183·9	72·9	105
Nil	*Nil*	*Nil*	V. s. t.	V. s. t.	V. s. t.	1·162	431·9	172·7	0·132	49·0	19·6	106
V. s. t.	V. s. t.	V. s. t.	*Nil*	*Nil*	*Nil*	0·986	380·7	151·7	0·220	84·9	33·8	107
V. s. t.	V. s. t.	V. s. t.	V. s. t.	V. s. t.	V. s. t.	1·197	578·2	230·8	0·308	148·8	59·4	108

NOTE.—U. r. t. = unreadable trace.
V. s. t. = very slight trace.
Tr. = trace.
S. tr. = slight trace.

Serial Number.	Names and Strength.	Alcoholic Strength Vol. per cent.			Acidity.		
		Apparent.	True.	Percentage obscuration.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.
1	2	3	4	5	6	7	8
109	Blend Pure old Scotch Whiskey, (Germany) ...	21·1	26·7	21·0	0·060	22·5	9·0
110	Blended Scotch Whiskey, (Germany) ...	19·4	25·0	22·4	0·060	24·0	9·6
111	No. 1 Brandy (Germany)	21·5	23·9	10·0	0·030	12·5	5·0

INDO—

Serial Number.	Names and Strength.	Apparent.	True.	Percentage obscuration.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.
112	Plain Spirit L. P.	56·5	57·0	0·9	0·971	170·4	68·0
113	Plain Spirit 21·2 O. P.	69·3	74·1	6·5	0·253	34·1	13·6
114	Rectified Spirit 64·3 O. P.	92·1	93·9	1·9	0·034	3·6	1·4
115	Rum 43·1 O. P.	81·6	82·5	1·1	0·253	30·6	12·2
116	Rectified spirit 57·3 O. P.	90·8	92·1	1·4	0·013	1·4	0·6
117	Whiskey 16·5 U. P.	47·3	47·6	0·6	0·374	78·6	31·4
118	Rum L. P.	56·5	56·8	0·5	0·109	19·2	7·6
119	Coloured Rum L. P.	57·7	59·9	3·7	0·078	13·0	5·2
120	Plain Spirit L. P.	56·9	57·0	0·2	0·182	33·0	13·2
121	Scented Spirit L. P.	57·4	57·9	1·6	0·052	9·0	3·5
122	Malt Whiskey L. P.	54·5	55·2	1·3	0·067	12·1	4·8
123	Molasses Spirit 33·6 O. P.	75·8	77·4	2·1	0·138	17·8	7·2
124	Jaggery „ 20·6 U. P.	46·4	46·8	0·8	1·320	282·1	112·7
125	Molasses „ 64·4 O. P.	93·5	94·0	0·5	0·036	3·8	1·5
126	Molasses spirit 60·1 O.P.	91·4	91·9	0·5	0·084	9·1	3·6
127	Jaggery „ 64·2 „	93·7	94·9	1·3	0·018	1·9	0·8
128	„ „ 40·2 „	80·1	80.3	0·2	0·102	12·7	5·1
129	„ „ 55·7 „	88·7	90·0	1·4	0·042	4·7	1·8
130	Whiskey L.P. ...	56·7	58·3	2·7	0·276	47·3	18·8
131	Brandy „ ...	56·2	57·5	2·3	0·144	26·8	10·0
132	Gin „ ...	56·4	57·6	2·1	0·588	102·1	40·8
133	Rum „ ...	56·4	58·3	3·2	0·204	35·0	13·8
134	Palm jaggery spirit 9·3 O.P.	61·5	64·4	4·5	0·296	46·0	18·4
135	„ and cane jaggery spirit 23·8 O.P. ...	71·3	72·2	1·2	0·270	37·4	14·9
136	Jaggery spirit 14·7 „ ...	65·2	65·7	0·8	0·492	75·0	29·9
137	„ 81·0 U.P. ...	11·3	11·5	1·7	1·332	1158·3	463·9
138	„ 0·4 O.P. ...	57·5	58·2	1·2	0·246	42·3	17·
139	„ 30·2 U.P. ...	40·8	41·2	0·9	1·248	302·9	121·
140	„ 20·0 „ ...	46·1	46·2	0·2	1·078	233·3	92·
141	Superior Brandy	42·9	44·0	2·5	0·090	20·4	8·
142	Whiskey	42·9	44·4	3·4	0·090	20·3	8·

Aldehydes.			Furfural.			Fusel oil as Amyl Alcohol.			Ethers.			
Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Serial Number.
9	10	11	12	13	14	15	16	17	18	19	20	
0·018	6·7	2·7	V. s. t.	V. s. t.	V. s. t.	0·466	174·5	69·8	0·792	296·6	118·5	109
V. s. t.	V. s. t.	V. s. t.	*Nil*	*Nil*	*Nil*	1·566	626·4	250·3	0·264	105·6	42·2	110
Nil	*Nil*	*Nil*	V. s. t.	V. s. t.	V. s. t.	0·211	88·3	35·3	0·308	128·8	51·6	111

II.

EUROPEAN SPIRITS.

Aldehydes.			Furfural.			Fusel oil as Amyl Alcohol.			Ethers.			
9	10	11	12	13	14	15	16	17	18	19	20	Serial Number.
0·157	27·5	11·0	0·015	2·6	1·1	1·640	287·7	114·9	0·211	37·0	14·8	112
0·165	22·2	8·9	*Nil*	*Nil*	*Nil*	1·645	221·9	88·7	0·229	30·9	12·3	113
0·088	9·3	3·7	*Nil*	*Nil*	*Nil*	0·968	103·1	41·2	0·178	18·7	7·4	114
0·071	0·8	0·3	Tr.	Tr.	Tr.	0·528	64·0	25·6	1·355	164·2	65·5	115
0·606	65·8	26·3	0·007	0·7	0·3	0·808	87·7	35·0	0·844	91·6	36·6	116
0·064	13·4	5·4	0·004	1·0	0·4	1·600	336·1	134·3	0·341	71·6	28·6	117
0·209	36·8	14·7	0·085	14·9	5·9	2·402	424·9	167·9	0·404	71·0	28·3	118
0·423	70·6	28·2	0·005	0·8	0·3	1·188	198·3	79·2	0·422	70·5	28·1	119
0·134	23·5	9·4	0·011	2·0	0·7	0·906	158·9	63·4	0·211	38·3	15·3	120
0·166	28·7	11·4	0·013	2·3	0·9	0·915	158·0	63·1	0·158	27·3	10·9	121
0·133	24·1	9·6	0·009	1·6	0·6	1·056	191·3	76·4	0·228	41·3	16·5	122
0·215	27·8	11·2	0·013	1·7	0·7	1·308	169·0	67·4	0·316	40·8	16·4	123
0·096	20·5	8·2	0·032	6·8	2·8	0·959	204·9	81·9	0·440	94·0	37·6	124
0·065	6·9	2·7	*Nil*	*Nil*	*Nil*	0·810	85·6	34·3	0·281	29·8	11·9	125
0·083	9·0	3·6	0·003	0·3	0·1	1·091	116·5	47·4	0·299	32·5	13.0	126
0·141	14·9	5·9	*Nil*	*Nil*	*Nil*	0·852	90·3	36·1	0·176	18·6	7·5	127
0·073	9·1	3·6	0·012	1·5	0·6	1·154	143·7	57·4	0·264	32·9	13·1	128
0·208	23·1	9·2	0·011	1·2	0·5	1·489	165·4	66·1	0·264	29·3	11·7	129
0·192	33·0	13·1	0·035	6·0	2·4	0·684	117·3	47·0	1·725	296·0	118·3	130
0·177	30·8	12·3	0·009	1·6	0·6	1·801	313·2	125·2	0·862	150·0	59·9	131
0·223	38·7	15·5	0·030	5·2	2·1	0·448	77·8	31·1	1·021	177·2	70·9	132
0·266	45·6	18·2	0·029	5·0	2·0	1·429	245·1	98·1	0·792	135·2	54·3	133
0·064	10·0	4·0	0·045	7·1	2·8	0·266	41·3	16·5	0·193	30·0	12·0	134
0·196	27·1	10·8	0·023	3·2	1·3	0·304	42·1	16·8	0·950	131·5	52·5	135
0·162	24·6	9·9	0·068	10·3	4·1	0·793	120·7	48·3	0·422	64·2	25·7	136
0·017	14·8	5·9	0·072	62·6	25·1	0·044	38·3	15·3	0·193	168·0	67·2	137
0·118	20·3	8·1	0·001	0·2	0·06	0·220	37·8	15·1	1·109	190·5	76·0	138
0·053	12·9	5·1	0·026	6·3	2·5	0·202	49·0	19·6	0·440	106·8	42·7	139
0·031	6·7	2·7	0·022	4·8	1·9	0·290	62·8	25·0	0·352	76·2	30·3	140
0·021	4·8	1·9	*Nil*	*Nil*	*Nil*	0·686	155·9	62·4	0·352	80·0	32·0	141
Nil	*Nil*	*Nil*	Tr.	Tr.	Tr.	0·519	116·9	46·7	0·308	69·3	27·7	142

Note.—V. s. t. = very slight trace.
Tr. = trace.

Serial Number.	Names and strength.	Alcoholic strength. Vol. per cent.			Acidity.		
		Apparent.	True.	Percentage obscuration.	Grams per litre.	Milligrams per 100 c. c. of absolute alcohol.	Grains per proof gallon.
1	2	3	4	5	6	7	8
143	Fine Old Tom Gin	42·7	43·8	2·5	0·060	13·7	5·5
144	Rum, superior quality	49·8	51·2	2·7	0·030	6·0	2·3
145	X Rum	50·8	53·4	4·9	0·180	33·7	13·5
146	XX Rum	50·5	52·4	3·6	0·120	22·9	9·1
147	XXX Rum	50·6	52·3	3·2	0·150	28·6	11·4
148	Coloured Rum L.P.	57·2	61·8	7·4	0·450	72·8	29·1
149	Gur Wash	...	7·4	...	0·330	445·9	177·7
150	Gur Wash, distilled	58·4	59·0	1·0	0·270	45·8	18·2
151	Rectified spirit 58·0 O.P.	90·0	91·2	1·3	...	...	...
152	Coloured Rum L. P. After casking 3½ months	54·9	57·6	4·7	0·210	36·5	14·5
					COUNTRY MAHUA SPIRIT:		
153	Mahua 25·0 U. P.	43·4	44·2	1·4	0·149	33·9	13·5
154	,, 60·0 ,, ...	...	22·7	...	0·229	100·7	40·1
155	,, 10·0 ,, ...	52·0	52·1	0·2	0·766	147·0	58·7
156	,, 20·0 ,, ...	45·3	50·1	5·9	0·684	136·5	54·5
157	,, 50·0 ,, ...	29·1	29·7	2·0	0·889	299·3	119·7
158	,, 25·0 ,, ...	42·8	43·8	2·3	0·519	118·5	47·4
159	,, 60·0 ,, ...	23·1	23·1	*Nil*	0·848	367·1	146·6
160	,, 68·0 ,, (outstill earthen degchi) ...	21·9	22·7	3·5	1·770	779·7	311·3
161	,, 34·2 ,, ,, ...	40·6	40 6	*Nil*	0·900	221·6	88·3
162	,, 60·4 ,, (outstill copper degchi) ...	26·8	26·9	0·3	0·690	256·5	102·5
163	,, 30·5 ,, ,, ...	42·7	43·4	1·6	0·330	76·0	30·4
164	,, 56·8 ,, ...	24·6	26·0	5·4	1·134	436·2	177·4
165	,, 60·1 ,, ...	23·0	24·4	5·7	0·783	320·9	128·3
166	,, 17·2 ,, (outstill copper degchi) ...	49·6	53·9	8·0	0·450	83·5	33·3
167	,, 50·2 ,, ,, ...	33·8	34·1	0·9	2·880	844·6	337·1
168	,, 25·0 ,, ...	43·3	44·2	2·0	0·270	61·1	24·4
169	,, 60·0 ,, (Rasi)	23·3	24·3	4·1	0·322	132·5	53·0
170	,, 25·0 ,, ...	42·5	43·4	2·1	0·930	214·3	85·6
171	,, 60·0 ,, ...	24·2	24·7	2·0	0·639	258·7	103·5
172	,, 25·0 ,, ...	43·0	43·8	1·8	0·036	8·2	3·3
173	Gur and Mahua 25·0 U. P. ...	43·2	44·3	2·0	2·424	547·2	218·7
174	,, 50·0 ,, ...	29·1	30·8	5·5	2·424	787·0	314·1
175	,, 10·0 ,, ...	51·0	51·8	1·5	2·082	409·8	160·5
176	,, 50·0 ,, ...	28·5	30·6	6·8	3·222	1,052·9	420·7
177	,, 70·0 ,, ...	16·9	17·7	4·5	3·762	2,125·4	849·4

Aldehydes.			Furfural.			Fusel oil as Amyl Alcohol.			Ethers.			Serial Number.
Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	
9	10	11	12	13	14	15	16	17	18	19	20	
Tr.	Tr.	Tr.	*Nil*	*Nil*	*Nil*	0·581	132·6	53·1	0·352	80·4	32·1	143
Tr.	Tr.	Tr.	*Nil*	*Nil*	*Nil*	0·730	142·6	57·0	0·572	111·7	44·6	144
0·036	6·7	2·7	Tr.	Tr.	Tr.	0·792	148·3	59·3	0·650	123·5	49·4	145
0·051	9·7	3·9	Tr.	Tr.	Tr.	0·854	163·1	65·1	0·484	92·3	36·8	146
0·048	9·1	3·6	Tr.	Tr.	Tr.	0·906	173·2	69·2	0·616	117·8	47·0	147
0·289	46·3	18·7	*Nil*	*Nil*	*Nil*	0·924	149·5	59·7	0·440	71·2	28·4	148
0·026	35·1	14·0	*Nil*	*Nil*	*Nil*	0·528	713·5	284·3	0·132	178·4	71·0	149
0·017	2·9	1·2	0·008	1·4	0·5	1·822	308·8	123·3	0·352	59·6	23·8	150
0·920	100·8	40·2	V. s. t.	V. s. t.	V. s. t.	...	...	...	...	...	...	151
0·135	23·4	9·3	*Nil*	*Nil*	*Nil*	1·698	294·8	117·9	0·352	61·1	24·4	152

III.

SPIRITS.

FIRE HEATED; SINGLE DISTILLATION.

0·082	18·6	7·4	0·071	16·1	6·3	1·100	250·0	99·9	0·792	180·0	71·9	153
0·162	71·3	28·3	0·032	14·3	5·7	...	...	...	...	...	...	154
0·309	59·3	23·7	0·026	4·9	1·9	0·910	174·6	69·8	0·528	101·3	40·5	155
0·266	53·0	21·2	0·038	7·6	3·0	0·818	163·2	65·2	0·440	87·8	35·0	156
0·176	59·2	23·7	0·021	7·1	2·8	0·760	255·9	102·3	0·229	77·1	30·8	157
0·094	21·5	8·6	0·022	5·0	2·0	1·370	312·8	125·2	0·581	132·7	53·1	158
0·145	62·8	25·1	0·011	4·7	1·9	1·180	510·8	204·0	0·316	136·8	54·6	159
0·047	20·7	8·3	0·039	17·1	6·8	0·185	81·5	32·5	1·100	484·5	193·5	160
0·167	41·1	16·4	0·015	3·7	1·5	0·880	216·7	85·4	0·660	162·5	64·8	161
0·042	15·6	6·2	0·023	8·5	3·4	0·466	173·2	69·2	0·264	98·1	39·2	162
0·113	26·0	10·4	0·011	2·5	1·0	0·810	186·6	74·6	0·616	141·0	56·7	163
0·116	44·6	17·9	0·037	14·2	5·7	0·488	187·7	75·4	0·106	40·7	16·4	164
0·094	38·5	15·4	0·038	15·6	6·2	0·326	133·6	53·4	0·281	115·1	46·0	165
0·131	24·3	9·7	0·005	0·9	0·4	2·112	391·8	156·4	0·616	114·3	45·6	166
0·042	12·3	4·9	0·019	5·6	2·2	0·642	188·2	75·1	1·144	335·5	133·9	167
0·108	24·5	9·9	0·051	11·5	4·6	0·651	147·3	58·9	0·228	51·6	20·6	168
0·043	17·7	7·0	0·024	9·9	4·0	0·630	259·3	103·8	0·105	43·2	17·3	169
0·085	20·0	7·9	0·044	10·1	4·1	0·387	89·1	35·6	0·193	44·5	17·7	170
0·047	19·0	7·6	0·019	7·7	3·0	0·813	329·1	131·7	0·088	35·6	14·3	171
0·088	20·1	8·0	0·056	12·8	5·0	1·162	265·3	104·7	0·123	28·1	11·1	172
0·277	62·5	25·0	0·042	9·5	3·9	0·456	103·0	41·0	1·435	324·0	129·5	173
0·088	28.6	11·4	0·033	10·7	4·3	0·836	271·4	108·4	1·232	400·0	159·7	174
0·091	17·6	7·0	0·054	10·4	4·2	1·355	261·6	104·2	1·725	333·0	132·7	175
0·067	21·8	8·7	0·034	11·1	4·4	0·934	305·2	121·9	1·056	345·1	137·9	176
0·045	25·4	10·1	0·011	30·0	12·4	0·501	283·0	113·1	0·387	218·6	87·3	177

Note.—V. s. t.—Very slight trace.
Tr.—Trace.

Serial Number.	Names and Strength.	Alcoholic strength. Vol. per cent.			Acidity.		
		Apparent.	True.	Percentage obscuration.	Grams per litre.	Miligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.
1	2	3	4	5	6	7	8
178	Gur and Mahua 78·0 U. P. ...	11·0	12·3	10·6	2·640	2146·3	855·5
179	„ 84·0 „ ...	8·4	9·2	8·7	1·884	2047·8	819·1
180	Mahua 25·0 „ ...	43·1	44·4	2·9	0·402	90·5	36·1
181	Mahua and Shira 0·9 „ ...	57·1	57·4	0·5	0·654	114·0	45·6
182	„ 24·2 „ ...	43·9	45·0	2·4	0·558	124·0	50·8
183	„ 23·4 „ ...	44·2	45·8	3·5	1·434	320·8	128·8
184	„ and Gur 25·2 „ ...	42·0	43·0	2·3	4·806	1117·7	446·8
185	„ Shira 25·2 „ ...	43·3	44·0	1·6	1·512	348·4	139·3
186	„ 25·0 „ ...	44·2	44·5	0·7	0·486	109·2	43·6
187	„ 20·0 „ ...	45·6	46·2	1·3	2·262	489.6	195·7
188	„ 24·1 „ ...	43·7	45·8	4·6	0·876	1·3	76·5
189	„ L. P. ...	56·5	57·6	1·9	0·810	140·6	56·2
190	„ 25·0 U. P. ...	41·3	47·0	12·1	4·464	950·0	378·8
191	„ and Shira L. P. ...	57·0	57·6	1·0	0·619	107·5	42·9
192	„ „ 25·0 U. P. ...	42·8	43·8	2·3	0·639	145·9	58·3
193	„ 0·9 O. P. ...	56·8	58·0	2·1	1·315	226·7	91·8
194	„ 24·6 U. P. ...	43·6	44·4	1·8	1·466	330·1	131·9
195	„ 51·0 „ ...	29·0	29·8	2·7	3·672	1,232·2	490·5
196	„ 10·8 „ ...	51·5	51·6	0·2	1·764	341·8	136·7
197	„ 46·1 „ ...	31·6	32·1	1·5	3·240	1,012·5	402·8
198	„ and Shira 0·6 O. P. ...	57·0	57·8	1·4	0·732	126·6	50·6
199	„ 23·8 U. P. ...	44·2	44·2	*Nil.*	0·882	199·5	79·7
200	„ 1·4 O. P. ...	58·3	59·2	1·5	1·950	329·4	131·6
201	„ and Gur L. P. ...	57·4	57·5	0·2	0·594	103·3	41·2
202	„ „ 50·0 U. P. ...	29·5	30·6	3·6	2·442	798·0	319·0
203	„ „ 60·0 „ ...	22·5	23·7	5·6	1·734	731·6	292·5
204	„ (Bombay still) 25·4 „ ...	42·9	44·0	2·5	1·898	439·4	175·5
205	„ 24·1 „ ...	44·2	45·0	1·5	1·612	358·2	143·4
206	„ 20·0 „ ...	45·7	46·2	1·1	1·008	218·2	87·1
207	„ 50·0 „ ...	29·7	31·4	5·4	1·488	473·9	189·4
208	„ 70·0 „ ...	16·5	17·3	4·6	2·316	1339·0	535·1
209	„ and gur 70·0 „ ...	16.5	16·9	2·4	1·038	614·2	245·5
210	„ „ 45·0 „ ...	32·0	33·8	5·3	2·046	605·3	242·0
211	„ 5·0 „ ...	54·0	54·2	0·4	0·948	174·9	69·8
212	„ 0·3 „ ...	56·8	57·6	1·4	1·140	198·0	79·2
213	„ 24·8 „ ...	43·1	43·4	0·7	1·860	428·6	171·2
214	„ 42·5 „ ...	34·3	34·6	0·9	1·950	563·6	225·6

ALDEHYDES.			FURFURAL.			FUSEL OIL AS AMYL ALCOHOL.			ETHERS.			
Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Serial Number.
9	10	11	12	13	14	15	16	17	18	19	20	
0·049	40·0	16·0	0·030	24·4	10·2	0·554	450·4	179·5	0·528	429·2	171·1	178
Nil.	*Nil.*	*Nil.*	0·019	20·7	8·3	0·213	231·5	92·6	0·546	593·4	237·3	179
0·065	14·6	5·8	0·052	11·7	4·7	0·686	154·5	61·7	0·536	120·7	48·2	180
0·178	31·0	12·4	0·048	8·4	3·3	0·555	96·7	38·7	0·845	147·2	58·9	181
0·107	23·8	9·5	0·015	3·3	1·3	0·494	109·8	43·8	0·986	219·1	87·6	182
0·127	28·4	11·4	0·058	12·9	5·2	0·633	141·6	56·6	1·425	318·8	127·4	183
0·105	24·4	9·8	0·027	6·3	2·5	0·578	134·4	53·7	1·316	306·0	122·4	184
0·147	33·9	13·5	0·062	14·3	5·7	0·653	150·5	60·2	1·056	243·3	97·3	185
0·101	22·7	9·0	0·016	3·6	1·4	0·699	157·1	62·7	0·457	102·7	41·0	186
0·154	33·3	13·3	0·047	10·2	4·0	0·433	93·7	37·4	3·274	708·6	283·3	187
0·150	32·7	13·1	0·012	2·6	1·0	0·448	97·8	39·1	0·457	99·7	39·9	188
0·127	22·0	8·8	0·034	5·9	2·3	0·041	180·7	72·2	1·091	187·4	75·2	189
0·100	21·3	8·5	0·021	4·5	1·8	0·706	150·2	59·9	1·284	273·2	108·9	190
0·148	25·7	10·2	0·016	2·7	1·1	0·266	46·1	18·4	0·985	171·0	68·4	191
0·183	41·8	16·7	0·036	8·2	3·3	0·100	22·8	9·1	0·932	212·8	85·1	192
0·238	41·0	16·6	0·035	6·0	2·4	0·266	45·8	18·5	2·120	365·5	148·1	193
0·179	40·3	16·1	0·040	9·0	3·6	0·122	27·5	10·9	1·302	293·2	117·1	194
0·033	11·1	4·4	0·038	12·8	5·1	0·122	41·0	16·3	1·302	437·0	174·6	195
0·261	50·6	20·2	0·062	12·0	4·8	0·319	61·8	24·7	3·274	634·5	253·8	196
0·058	18·0	7·2	0·038	11·8	4·7	0·129	40·2	16·0	1·162	362·0	144·5	197
0·144	24·9	9·9	0·042	7·3	2·9	0·137	23·7	9·4	0·827	143·1	57·2	198
0·100	22·6	9·0	0·034	7·7	3·1	0·783	177·1	70·8	0·722	163·3	65·3	199
0·338	57·1	22·8	0·103	17·4	7·0	1·641	277·2	110·8	4·100	692·6	276·8	200
0·138	24·0	9·6	0·071	12·4	4·9	0·418	72·7	29·0	1·801	313·2	125·1	201
0·064	20·9	8·4	0·045	14·7	5·9	0·023	7·5	3·0	2·024	661·4	264·2	202
0·046	19·4	7·8	0·038	16·0	6·4	0·038	16·0	6·4	1·836	774·7	309·7	203
0·106	24·5	9·8	0·049	11·3	4·5	0·529	122·5	49·0	1·443	334·0	133·4	204
0·088	19·6	7·9	0·023	5·1	2·0	0·335	74·4	29·8	1·056	234·7	93·9	205
0·197	42·6	17·0	0·042	9·1	3·6	0·846	183·3	73·1	1·196	258·8	103·4	206
0·037	11·8	4·7	0·039	12·4	5·0	0·495	157·7	63·0	1·337	426·1	170·2	207
0·023	13·3	5·3	0·024	13·9	5·5	0·246	142·2	56·8	0·739	427·2	170·7	208
0·017	10·1	4·0	0·010	6·0	2·7	0·246	265·6	106·2	0·809	478·7	191·3	209
0·054	16·0	6·4	0·015	4·4	1·8	1·155	341·7	136·6	1·232	364·5	145·7	210
0·046	8·5	3·4	0·040	7·4	3·0	0·626	115·5	46·1	1·672	308·5	123·0	211
0·092	16·0	6·4	0·015	2·6	1·0	0·564	98·0	39·2	0·510	88·5	35·4	212
0·059	13·6	5·4	0·042	9·7	4·0	0·238	54·9	21·9	0·915	210·8	84·3	213
0·052	15·0	6·0	0·020	5·8	2·3	0·458	132·3	53·0	0·651	188·1	75·3	214

Serial Number.	Names and strength.	Alcoholic strength. Vol. per cent.			Acidity.		
		Apparent.	True.	Percentage obscuration.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.
1	2	3	4	5	6	7	8
215	Mahua and shira 23·2 U. P. ...	43·1	44·6	3·4	1·386	310·8	124·4
216	" 40·0 " ...	35·8	36·0	0·6	1·026	285·0	113·6
217	" 25·0 " ...	44·0	44·2	0·4	1·020	230·8	92·3
218	" 25·0 " ...	42·9	44·2	3·0	0·708	160·2	64·0
219	" and date Chitta 17·6 " ...	47·0	47·2	0·4	1·416	300·0	119·9
220	" 50·0 " ...	29·5	29·9	1·3	0·960	321·1	128·0
221	" 70·0 " ...	16·5	16·6	0·6	0·948	571·1	228·0
222	" 24·8 " ...	42·7	43·0	0·7	0·396	92·1	36·8
223	" and Molasses 19·7 " ...	46·5	46·8	0·7	1·998	426·9	170·5
224	" " 69·9 " ...	16·9	17·7	4·6	2·664	1496·7	597·7
225	" " 50·0 " ...	29·1	30·0	3·0	2·808	936·0	373·7
226	" 25·2 " ...	43·3	44·0	1·6	0·924	210·0	84·0
227	" and Gur 65·0 " ...	19·3	20·0	3·5	1·680	840·0	336·0
228	" " 87·0 " ...	6·6	7·2	8·3	1·182	1641·7	656·7
229	" 24·8 " ...	43·5	44·2	1·5	1·370	310·0	124·0
230	" 20·0 " ...	45·7	46·4	1·5	2·210	476·3	190·0
231	" 50·0 " ...	28·2	28·6	1·4	2·730	954·5	381·4
232	" 70·0 " ...	17·4	17·7	1·7	2·352	1329·0	531·0
233	" and Gur 20·0 " ...	46·5	46·6	0·2	0·426	91·4	36·5
234	" " 50·0 " ...	29·9	30·4	1·6	1·380	455·0	181·2
235	" " 68·0 " ...	18·6	19·0	2·1	1·524	802·1	320·4
236	" " 86·0 " ...	9·0	10·0	10·0	0·132	132·0	52·5
237	" " 20·0 " ...	45·0	45·0	*Nil*	1·782	396·0	158·5
238	" " 50·0 " ...	29·2	29·9	2·3	2·298	768·5	307·6
239	" " 70·0 " ...	17·3	17·9	3·4	2·496	1394·4	556·4
240	" " —— ...	41·5	42·6	2·6	0·690	161·9	64·7
241	" (Bombay still) 25·4 " ...	40·6	43·0	5·6	2·550	593·0	237·0
242	" and Gur 57·3 " ...	26·6	27·2	2·2	1·860	683·8	273·0
243	" " 20·0 " ...	46·2	46·4	0·4	1·680	362·1	144·6
244	" " 69·0 " ...	18·1	18·7	3·2	1·350	721·9	288·9
245	" " 10·0 " ...	51·6	52·2	1·1	2·340	448·3	178·8
246	" " 77·0 " ...	13·5	13·8	2·2	1·410	1021·7	407·8
247	" " 50·0 " ...	29·4	30·8	4·5	3·450	1120·1	447·2
248	" and Shira 24·2 " ...	44·2	45·0	1·8	3·300	733·3	293·9
249	" " 1·6 O. P. ...	55·8	56·4	1·0	1·260	223·4	89·2
250	" 1·5 " ...	57·8	58·6	1·4	1·680	286·7	114·5

ALDEHYDES.			FURFURAL.			FUSEL OIL AS AMYL ALCOHOL.			ETHERS.			Serial number.
Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c. c., of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c. c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c. c. of absolute alcohol.	Grains per proof gallon.	
9	10	11	12	13	14	15	16	17	18	19	20	
0·075	16·8	6·7	0·052	11·7	4·7	0·282	63·2	25·3	1·038	232·7	93·2	215
0·038	10·6	4·2	0·100	27·8	11·1	0·405	112·5	44·9	0·264	73·3	29·2	216
0·100	22·6	9·0	0·065	14·7	5·9	0·238	54·1	21·5	0·616	139·4	55·7	217
0·055	12·4	5·0	0·046	10·4	4·2	0·511	115·6	46·2	0·950	214·9	86·0	218
0·070	14·8	6·0	0·030	6·3	2·5	0·441	93·4	37·3	0·475	100·7	40·2	219
0·052	17·4	6·9	0·028	9·4	3·7	0·626	209·3	83·5	0·246	82·3	32·8	220
0·026	15·7	6·3	0·011	6·6	2·6	0·248	149·4	59·7	0·299	180·1	71·8	221
Nil	*Nil*	*Nil*	0·027	6·3	2·5	0·379	88·1	35·2	1·514	352·1	140·8	222
0·109	23·3	9·3	0·004	0·9	3·0	1·040	222·2	88·8	0·915	195·5	78·2	223
0·024	13·5	5·4	0·021	11·8	4·7	0·211	118·5	47·3	0·211	118·5	47·3	224
0·051	17·0	6·8	0·026	8·7	3·5	0·687	229·0	91·4	0·510	170·0	67·9	225
0·059	13·4	5·4	0·023	5·2	2·1	0·476	108·2	43·3	1·372	31·2	124·7	226
0·018	9·0	3·6	0·017	8·5	3·4	0·264	132·0	52·8	0·950	475·0	190·0	227
0·013	18·1	7·2	0·011	15·3	6·1	0·176	245·6	97·8	0·387	537·5	215·0	228
0·084	19·0	7·6	0·012	2·7	1·1	0·247	56·0	22·3	1·144	258·8	103·5	229
0·111	24·0	9·6	0·024	5·2	2·1	0·503	108·4	43·3	0·633	136·2	54·5	230
0·057	20·0	7·9	0·018	6·3	2·5	0·273	95·5	38·1	0·950	332·2	132·5	231
0·044	25·0	9·9	0·020	11·3	4·5	1·102	622·6	249·0	0·334	188·7	75·4	232
0·123	26·4	10·6	0·070	15·0	6·0	0·176	37·8	15·1	0·792	170·0	67·9	233
0·055	18·1	7·2	0·050	16·4	6·8	0·573	188·5	75·3	0·580	190·8	76·2	234
0·024	12·6	5·0	0·024	12·6	5·0	0·176	92·6	37·0	1·091	574·2	229·3	235
Nil	*Nil*	*Nil*	0·026	26·0	10·3	0·044	44·0	17·5	1·513	1513·0	601·8	236
0·049	11·0	4·4	0·022	5·0	2·0	0·652	145·0	58·0	0·651	144·4	57·9	237
0·034	11·4	45·5	0·014	4·7	1·9	0·432	144·5	57·8	0·510	204·0	68·2	238
0·024	13·4	5·4	0·012	6·7	2·7	0·229	128·0	51·0	0·088	49·2	19·3	239
V. s. t.	V. s. t.	V. s. t.	*Nil*	*Nil*	*Nil*	0·871	204·4	81·7	0·572	134·2	53·6	240
0·066	15·3	6·1	V. s. t.	V. s. t.	V. s. t.	1·689	392·8	157·0	1·364	317·2	126·8	241
0·023	8·5	3·4	0·041	15·1	6·0	0·150	55·2	22·0	0·572	120·3	84·7	242
0·066	14·2	5·7	*Nil*	*Nil*	*Nil*	0·794	171·1	68·4	2·904	626·0	250·7	243
0·021	11·2	4·4	0·013	6·9	2·7	0·308	164·7	65·9	0·396	211·7	84·0	244
0·102	19·5	7·8	0·028	5·4	2·1	1·267	242·7	96·8	0·220	42·1	16·8	245
0·019	13·7	5·5	0·006	4·3	1·7	0·766	555·0	221·5	0·396	286·9	114·5	246
0·033	10·7	4·3	0·019	6·2	2·5	0·651	211·4	84·4	0·352	114·3	45·6	247
0·044	9·8	3·9	0·008	1·7	0·7	0·801	178·0	71·4	2·508	557·3	223·4	248
0·106	18·8	7·5	0·009	1·6	0·7	0·653	115·8	46·2	2·156	382·3	152·6	249
0·091	15·5	6·2	0·038	6·5	2·6	1·147	195·7	78·0	3·300	563·2	225·0	250

Note.—V. s. t.=Very slight trace.

Serial Number.	Names and strength.				Alcoholic strength. Vol. per cent.			Acidity.		
					Apparent.	True.	Percentage obscuration.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.
1	2				3	4	5	6	7	8
251	Mahua	23·0	U. P.	...	44·2	44·6	0·9	2·760	618·8	247·7
252	„	55·2	„	...	27·0	28·2	4·3	1·650	585·1	233·3
253	„	41·6	„	...	33·7	34·8	3·1	1·860	534·5	213·6
254	„	51·3	„	...	28·6	29·4	2·7	2·160	734·7	293·6
255	„	37·9	„	...	36·4	37·0	1·6	2·070	560·0	223·6
256	„	59·3	„	...	24·5	25·4	3·5	1·890	744·0	297·9
257	„	38·4	„	...	36·7	37·2	1·3	1·710	460·0	183·9
258	„	48·9	„	...	30·3	31·6	4·1	1·830	579·1	232·0
259	„	57·7	„	...	24·9	25·8	3·5	1·290	500·0	200·0
260	„	60·0	„	...	23·4	24·2	3·3	1·110	458·6	183·2
261	„	60·2	„	...	23·7	24·1	1·7	1·680	697·0	278·6
262	„	47·1	„	...	30·9	32·3	4·3	0·330	102·1	40·8
263	„	55·8	„	...	25·6	26·3	2·7	1·260	479·1	191·3
264	„	44·6	„	...	32·2	33·6	4·2	1·200	357·1	142·6
265	„	20·0	„	...	46·9	47·4	1·0	1·650	348·1	139·1
266	„	50·0	„	...	29·7	30·8	3·6	2·430	788·9	315·0
267	„	70·0	„	...	17·4	17·6	1·1	1·410	801·1	320·4
268	„	48·9	„	...	29·7	31·4	5·4	3·270	1041·4	416·0
269	„	57·6	„	...	25·1	26·5	5·3	3·420	1291·0	516·0
270	„	34·6	„	...	37·1	37·4	0·8	1·650	441·2	176·3
271	„	43·4	„	...	32·2	33·2	3·0	1·500	451·8	180·4
272	„	56·3	„	...	25·7	26·2	1·5	1·890	721·4	288·2
273	„	25·0	„	...	43·3	44·4	2·5	0·690	155·4	62·1
274	„	59·7	„	...	24·3	24·4	0·4	0·630	258·2	103·3
275	„	50·4	„	...	29·2	29·9	2·3	1·230	411·4	164·6
276	„	24·2	„	...	44·2	44·8	1·3	1·170	261·2	104·6
277	„	13·9	O. P.	...	64·8	66·0	1·8	0·270	41·0	16·4
278	„	22·7	U. P.	...	43·6	44·4	1·8	0·360	81·1	32·4
279	„	58·6	„	...	23·2	23·7	2·1	0·750	316·4	126·5
280	„	70·8	„	...	19·9	20·3	2·0	1·380	680·0	271·4
281	„	25·2	„	...	43·7	45·0	2·9	0·660	146·7	58·7
282	„	12·2	„	...	50·7	52·0	2·5	0·630	121·1	48·4
283	„	54·0	„	...	28·6	28·9	1·0	0·540	186·8	74·1
284	„	38·3	„	...	35·0	35·5	1·4	0·900	253·5	101·3
285	„	48·3	„	...	26·5	27·6	4·0	1·260	456·5	182·2

ALDEHYDES.			FURFURAL.			FUSEL OIL AS AMYL ALCOHOL.			ETHERS.			
Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Serial number.
9	10	11	12	13	14	15	16	17	18	10	20	
Nil	*Nil*	*Nil*	0·065	14·6	5·8	0·397	89·0	35·6	2·332	522·8	209·3	251
0·045	16·0	6·4	0·025	9·0	3·5	0·722	255·7	102·1	0·520	184·4	73·5	252
0·024	7·0	2·8	0·010	3·0	1·1	0·625	179·6	71·8	0·704	202·3	80·9	253
0·048	16·3	65·2	0·022	7·5	3·0	0·264	89·8	36·0	0·704	239·5	95·7	254
0·018	5·0	2·0	0·012	3·2	1·3	0·458	123·8	49·5	0·570	154·0	61·6	255
0·025	9·8	3·9	0·029	11·4	4·6	0·308	121·2	48·5	0·308	121·2	48·5	256
0·055	14·8	5·9	0·025	6·7	2·7	0·792	212·9	85·1	0·792	212·9	85·1	257
Nil	*Nil*	*Nil*	0·013	4·1	1·6	0·449	142·0	56·9	0·660	208·8	83·7	258
0·024	9·3	3·7	0·014	5·4	2·1	0·370	143·4	57·3	0·396	153·5	61·3	259
0·045	18·6	7·4	0·029	12·0	4·8	0·713	294·6	117·7	0·660	272·7	109·0	260
0·070	29·0	11·6	0·009	3·6	1·4	0·422	175·1	70·0	0·264	109·5	43·8	261
0·058	18·0	7·2	0·026	8·0	3·2	0·546	169·0	67·6	3·036	939·9	376·1	262
0·061	23·2	9·3	0·014	5·3	2·1	0·176	67·0	26·7	0·352	133·8	53·4	263
0·073	21·7	8·7	0·022	6·5	2·6	0·361	107·4	43·0	0·284	84·5	34·0	264
0·025	5·2	2·1	0·021	4·4	1·7	0·854	180·1	72·0	0·088	18·5	7·4	265
Nil	*Nil*	*Nil*	0·017	5·5	2·2	0·326	105·8	42·2	0·308	100·0	39·9	266
Nil	*Nil*	*Nil*	0·010	5·6	2·3	0·194	110·2	44·0	1·188	675·0	270·0	267
0·053	17·0	6·7	0·016	5·1	2·0	0·581	185·0	74·0	0·308	98·1	39·2	268
0·030	11·3	4·5	0·015	5·7	2·3	0·625	235·5	94·3	0·264	99·6	40·0	269
0·034	9·1	3·6	0·002	0·6	0·2	1·012	270·6	108·0	0·924	247·1	98·8	270
0·040	12·0	4·8	0·035	10·5	4·2	0·704	212·0	84·7	0·792	238·6	95·2	271
0·020	7·6	3·1	0·006	2·3	1·0	0·317	121·0	48·3	1·232	470·2	188·0	272
0·086	19·4	7·8	0·029	6·5	2·6	0·141	31·8	12·7	0·616	138·8	55·5	273
0.033	13·5	5·4	0·016	6·5	2·6	0·387	158·6	63·4	0·088	36·1	14·4	274
0·048	16·0	6·4	0·023	7·7	3·1	0·598	200·0	80·0	0·440	147·2	59·0	275
0·105	23·4	9·4	0·065	14·5	5·8	0·730	163·0	65·3	1·232	275·0	110·1	276
0·210	31·8	13·0	0·065	9·8	4·0	0·906	137·3	55·0	0·352	53·3	21·3	277
0·065	14·6	5·7	0·071	16·0	6·4	0·176	39·6	15·8	0·308	69·4	27·7	278
0·072	30·4	12·1	0·035	14·6	5·9	0·352	148·5	59·3	0·220	92·8	37·1	279
0·042	20·6	8·2	0·024	11·8	4·7	0·290	142·3	57·0	0·924	455·2	181·5	280
0·065	14·4	5·8	0·026	5·8	2·3	1·267	281·5	112·7	0·572	127·1	50·9	281
0·093	18·0	7·1	0·021	4·0	1·6	1·558	299·6	119·6	1·408	270·8	108·1	282
0·035	12·1	4·8	0·019	6·6	2·6	0·062	21·5	8·5	0·352	121·8	48·6	283
0·042	11·8	4·7	0·016	4·5	1·8	0·581	163·7	65·4	0·484	136·3	54·7	284
0·102	36·9	14·7	0·022	7·9	3·1	0·229	82·9	33·1	0·308	111·5	44·5	285

Serial Number.	Names and strength.	Alcoholic strength. Vol. per cent.			Acidity.		
		Apparent.	True	Percentage Obscuration.	Grams per litre.	Milligrams per 100 c. c. of absolute alcohol.	Grains per proof gallon.
1	2	3	4	5	6	7	8
286	Mahua 56·3 U. P. ...	30·5	31·7	3·8	1·440	454·2	181·2
287	„ 52·4 „ ...	42·6	44·4	4·0	0·690	155·4	62·1
288	„ 25·0 „ ...	41·7	42·6	2·1	0·570	133·8	53·4
289	„ 60·0 „ ...	23·0	24·6	6·5	0·722	292·6	116·6
290	„ 25·4 „ ...	42·2	43·2	2·3	0·660	152·7	61·0
291	„ 60·3 „ ...	23·3	24·0	2·9	0·060	25·0	9·9
292	„ 61·0 „ ...	21·6	22·5	4·0	0·090	40·0	16·0
293	„ 25·0 „ ...	43·3	44·6	2·9	0·330	73·9	29·6
294	„ 64·8 „ ...	25·0	25·2	0·8	2·610	1035·7	414·4
295	„ 62·7 „ ...	26·7	26·9	0·8	2·100	780·1	311·4
296	„ 12·5 „ ...	53·0	53·9	1·7	1·410	261·6	104·4
297	„ 25·2 „ ...	46·0	46·6	1·3	2·280	489·3	195·6
298	„ 0·9 O. P. ...	56·7	59·2	4·2	1·560	263·5	105·5
299	„ and Gur L. P. ...	57·1	59·4	4·0	0·690	116·1	46·4
300	„ (Bombay still) 25·4 U. P. ...	42·9	43·8	2·0	2·130	486·3	194·4
301	„ 11·2 „ ...	50·7	51·6	1·7	0·210	40·7	16·2
302	„ 45·4 „ ...	31·8	33·3	4·5	0·570	171·1	70·5
303	„ wash	...	6·2	...	4·230	6822·6	2716·5
304	„ 25·0 U. P. ...	42·4	44·0	3·6	2·700	613·6	245·1
305	„ wash	...	10·7	...	6·300	5887·8	2345·7
306	„ 9·8 U. P. ...	52·0	53·4	2·6	1·380	258·4	103·3
307	„ wash	...	7·7	...	...	...	...
308	„ 25·1 U. P. ...	42·9	48·6	11·4	...	...	...
309	„ 60·0 „ ...	23·2	24·2	5·0	1·710	706·6	282·3
310	„ 60.0 „ ...	23·1	24·2	4·1	1·650	681·8	272·4
311	„ and gur	38·7	39·8	2·8	1·020	256·3	102·5
312	„	42·5	43·6	2·5	1·440	330·3	132·3
313	„ wash	...	9·9	...	...	...	...
314	„ 44·4 U. P. ...	32·3	32·8	1·5	...	...	...
315	„ 0·8 O. P. ...	57·5	58·0	0·8	...	...	...
316	„ wash	...	11·9	...	...	...	...
317	„ 24·4 U. P. ...	42·5	43·2	1·6	...	...	...
318	„ wash	...	11·3	...	...	...	...
319	„ 50·5 U. P. ...	29·8	31·1	4·1	...	...	...
320	„ (outstill)	7·8	9·2	15·2	...	...	...
321	„ and Gur (outstill) ...	6·4	7·0	8·6	...	...	...

ALDEHYDES.			FURFURAL.			FUSEL OIL AS AMYL ALCOHOL.			ETHERS.			
Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Serial number.
9	10	11	12	13	14	15	16	17	18	19	20	
0·055	17·3	6·9	0·015	4·7	1·8	0·317	100·0	39·9	0·352	111·0	44·3	286
0·114	25·6	10·2	0·023	5·1	2·0	0·422	95·0	38·0	0·484	109·0	43·6	287
0·137	32·1	12·8	0·038	8·9	3·5	0·493	115·7	46·2	0·308	72·3	28·9	288
0·078	31·7	12·6	0·033	13·4	5·3	0·792	321·9	128·3	0·176	71·5	28·5	289
0·061	14·1	5·6	0·005	1·1	0·4	0·739	171·0	68·3	0·044	10·1	4·0	290
0·032	13·3	5·3	0·003	1·2	0·5	0·484	201·6	80·2	0·088	36·6	14·5	291
0·061	27·1	10 8	0·006	2·7	1·0	0·475	211·1	84·6	0·308	136·8	54·8	292
0·202	45·2	18·1	0·007	1·5	0·6	0·748	167·7	67·1	1·053	236·0	94·5	293
0·026	10·3	4·1	0·008	3·2	1·2	0·616	244·4	97·8	1·320	523·8	209·5	294
0·027	10·0	4·0	0·006	2·2	0·9	0·704	261·7	104·4	0·968	360·0	143·6	295
Nil	*Nil*	*Nil*	0·027	5·0	2·0	1·012	187.7	74·9	0·880	163·3	65·2	296
0·087	18·7	7·4	0·011	2·3	0·9	1·188	254·9	101·9	2·860	613·7	245·3	297
0·232	39·2	15·6	0·033	5·5	2·2	1·056	178·3	71·3	1·584	267·5	107·2	298
0·131	22·0	8·8	0·043	7·2	2·9	1·681	282·9	113·1	1·716	288·8	115·5	299
0·137	31·3	12·5	0·029	6·6	2·6	1·109	253·2	101·2	1·672	381·7	152·6	300
0·222	43 0	17·2	0·002	0·4	0·1	0·669	129·3	51·8	0·352	68·2	27·3	301
0·098	29·4	12·1	0·009	0·3	0·1	0·625	187·7	77·3	0·176	52·9	21·7	302
0·030	48·4	19·2	V. s· t.	V. s. t.	V. s. t.	1·434	2312·9	920·9	0·520	838·7	333·9	303
0·088	20·0	7·9	0·013	2·9	1·2	1·144	260·0	103·8	2·772	630·0	251·6	304
0·053	49·5	19·7	0·001	0·9	0·4	0·317	296·2	118·0	1·672	1562·6	622·5	305
0·256	47·9	19·1	0·018	3·3	1·3	1·355	253·7	101·4	1·540	288·4	115·3	306
U. t.	U. t.	U. t.	U. t.	U. t.	U. t.	...	...	...	...	...	...	307
0·038	7·8	3·1	0·026	5·6	2·0	...	...	...	...	...	...	308
0·006	2·5	1·0	0·015	6·2	2·5	...	...	...	...	...	...	309
...	...	...	...	...	...	...	...	...	...	...	...	310
0·151	37·9	15·2	0·015	3·7	1·5	0·686	172·4	68·9	0·352	88·4	35·4	311
0·143	32·8	13·1	0·004	0·9	0·04	0·704	161·5	64·5	0·520	119·3	47·6	312
0·011	11.1	4·4	0·002	2·0	0·8	...	...	...	...	...	...	313
0·056	17·1	6·8	0·025	7·9	3·1	...	...	...	...	...	...	314
0·148	25·5	10·2	0·012	2·1	0·8	...	...	...	...	...	...	315
0·046	40·0	15·5	Tr.	Tr.	Tr.	...	...	...	...	...	...	316
0·127	30·0	11·7	0·030	7·0	2·8	...	...	...	...	...	...	317
0·130	115·0	46·2	0·003	2·7	1·1	...	...	...	...	...	...	318
0·237	76·2	30·5	0·017	5·5	2·2	...	...	...	...	...	...	319
...	...	...	...	...	...	...	...	...	...	...	...	320
...	...	...	...	...	...	...	...	...	...	...	...	321

Note.—V. s. t. = Very slight trace.
U. t. = Unreadable trace.

Serial Number.	Names and strength.	Alcoholic strength. Vol. per cent. Apparent.	Alcoholic strength. Vol. per cent. True.	Alcoholic strength. Vol. per cent. Percentage Obscuration.	Acidity. Grams per litre.	Acidity. Milligrams per 100 c.c. of absolute alcohol.	Acidity. Grains per proof gallon.
1	2	3	4	5	6	7	8
322	Mahua and Molasses ...	27·1	27·3	0·7	0·600	219·8	87·7
323	„ and gur (outstill) 93·1 U. P. ...	5·1	5·7	10·5	0·720	1263·1	504·0
324	„ 0·9 O. P. ...	53·6	54·0	0·7	1·200	222·2	88·6
325	„ and gur L. P. ..	55·6	56·8	2·1	1·200	211·2	84·3
					MAHUA SPIRIT :		
326	„ 26·8 U. P. ...	42·0	44·2	5·0	0·421	95·2	38·1
327	„ 25·0 „ ...	42·4	43·0	1·4	0·398	92·5	36·9
328	„ 25·0 „ ...	43·4	44·9	3·3	0·276	61·5	24·5
329	„ 19·5 „ ...	46·0	46·8	1·7	0·900	192·3	77·0
330	„ 20·7 „ ...	45·4	46·2	1·7	0·510	110·4	44·8
331	„ 21·7 „ ...	46·4	46·8	0·8	0·960	205·1	82·1
332	„ 21·7 „ ...	45·2	46·2	2·2	0·720	155·9	62·2
333	„ 20·3 „ ...	46·3	46·6	0·6	1·860	399·1	159·5
334	„ 17·7 „ ...	47·7	48·4	1·4	0·990	204·5	81·7
335	„ 20·7 „ ...	45·4	46·8	3·0	1·020	217·9	87·2
336	„ 20·3 „ ...	45·5	46·6	2·6	0·780	167·4	67·0
337	„ 20·3 „ ...	45·8	46·2	0·9	0·570	123·4	49·2
338	„ 21·0 „ ...	45·2	46·6	3·0	0·900	193·1	77·2
339	„ 20·6 „ ...	45·8	46·6	1·7	1·110	238·2	95·2
340	„ 18·8 „ ...	46·3	46·6	0·6	0·450	96·6	38·6
341	„ 20·9 „ ...	44·9	45·1	0·4	0·750	166·3	66.4
342	„ 20·6 „ ...	45·2	46·6	3·0	0·750	160·9	64·3
					MAHUA SPIRIT,		
343	„ 49·4 „ ...	28·7	30·1	4·6	1·082	359·4	143·4
344	„ 25·0 „ ...	43·1	43·8	1·6	0·372	84·9	33·9
345	„ 55·0 „ ...	26·3	27·2	3·3	1·140	419·1	167·3
346	„ 55·0 „ ...	25·4	26·5	4·1	2·100	792·5	316·8
					MAHUA SPIRIT,		
347	„ 22·2 „ ...	44·3	45·6	2·8	0·626	137·3	54·8
348	„ 21·3 „ ...	44·8	45·5	1·5	0·480	105·5	42·2
349	„ 21·4 „ ...	44·8	45·0	0·4	0·720	160·0	64·0
		RICE, RAISINS, DATE AND TODDY					
350	Rice 40·0 „ ...	33·4	34·0	1·8	0·258	77·2	30·9
351	„ 12·0 „ ...	49·7	51·6	3·7	0·694	134·5	53·9
352	„ 40·0 „ ...	34·8	35·0	0·6	1·345	387·4	156·0
353	Toddy 60·0 „ ...	21·9	22·7	3·6	3·508	1545·8	617·0

ALDEHYDES.			FURFURAL.			FUSEL OIL AS AMYL ALCOHOL.			ETHERS.			
Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Serial number.
9	10	11	12	13	14	15	16	17	18	19	20	
V. s. t.	V. s. t.	V. s. t	0·004	1·5	0·6	0·264	96·7	38·6	1·012	370·7	147·9	322
V. s. t.	V. s. t.	V. s. t.	V. s. t.	V. s. t.	V. s. t.	0·238	417·5	166·6	0·044	77·2	30·8	323
Tr.	Tr.	Tr.	0·008	1·5	0·6	0·959	177·6	70·8	1·408	260·7	103·9	324
0·097	17·1	6·8	0·016	2·8	1·1	1·557	274·1	109·4	1·452	255·6	102·0	325

FIRE HEATED; DOUBLE DISTILLATION.

9	10	11	12	13	14	15	16	17	18	19	20	
0·075	16·9	6·8	0·048	10.8	4·3	1·475	333·7	133·4	0·282	63·8	25·5	326
0·213	49·5	19·8	0·039	9·1	3·6	1·513	351·8	140·4	0·264	61·4	24·5	327
0·036	8·0	3·2	0·022	5·0	2·0	0·264	58·8	23·5	0·528	117·6	47·0	328
0·019	4·0	1·6	0·058	12·4	5·0	0·598	127·8	51·0	*Nil,*	*Nil.*	*Nil.*	329
Nil.	*Nil.*	*Nil.*	0·051	11·0	4·5	0·695	150·4	61·0	0·264	57·1	23·2	330
0·048	10·3	4·1	0·035	7·5	3·0	0·475	101·5	40·6	0·748	160·0	64·0	331
0·037	8·0	3·2	0·052	11·2	4·5	0·678	146·7	58·6	0·330	71·4	28·5	332
Nil.	*Nil.*	*Nil.*	0·058	12·4	4·9	0·590	126·6	50·6	0·220	47·2	18·8	333
0·063	13·0	5·2	0·042	8·7	3·5	1·302	269·0	107·5	0·792	163·6	65·4	334
Nil.	*Nil.*	*Nil.*	0·022	4·8	1·9	0·572	122·2	48·8	*Nil.*	*Nil.*	*Nil.*	335
0·029	6·2	2·5	0·032	6·9	2·7	0·713	153·0	61·2	0·088	19·1	7·5	336
0·068	14·7	5·9	0·042	9·1	3·6	0·792	171·4	68·4	0.176	38·1	15·2	337
Nil.	*Nil.*	*Nil.*	0·045	9·7	3·8	0·396	84·9	33·9	0·264	56·6	22·6	338
0·034	7·3	2·9	0·032	6·9	2·7	1·672	358·5	143·4	0·396	85·0	34·0	339
0·056	12·0	4·8	0·025	5·4	2·1	0·537	115·2	46·1	0·132	28·3	11·3	340
0·044	9·8	4·0	0·032	7·1	2·8	0·519	115·0	46·0	0·132	29·3	11·7	341
0·104	22·3	8·9	0·032	6·9	2·7	1·144	245·5	98·1	0·396	84·9	33·9	342

STEAM HEATED, SINGLE DISTILLATION.

9	10	11	12	13	14	15	16	17	18	19	20	
0·102	33·8	13·5	0·047	15·5	6·2	0·879	292·0	116·5	0·370	122·9	48·9	343
0·105	23·9	9·6	0·035	7·9	3·2	0·167	38·1	15·1	0·546	124·6	49·8	344
0·076	28·0	11·2	0·040	14·7	5·9	0·827	304·0	121·4	0·264	97·0	38·7	345
0·057	21·5	8·6	0·095	35·8	14·3	0·211	79·6	31·8	0·308	116·2	46·5	345

STEAM HEATED, DOUBLE DISTILLATION.

9	10	11	12	13	14	15	16	17	18	19	20	
0·147	32·2	12·8	0·070	15·4	6·1	0·602	132·0	52·7	0·405	88·8	35·4	347
0·070	15·4	6·2	0·061	13·4	5·4	1·118	245·7	98·2	0·220	48·4	19·3	348
0·091	20·2	8·0	0·139	31·0	12·4	0·546	121·3	48·6	0·520	115·6	46·3	349

SPIRITS, ETC., FIRE HEATED, SINGLE DISTILLATION.

9	10	11	12	13	14	15	16	17	18	19	20	
0·099	29·6	11·8	0·011	3·3	1·3	1·700	509·0	203·4	1·038	310·8	124·2	350
0·236	45·7	18·3	0·003	0·6	0·2	1·690	327·5	131·2	1·478	286·4	114·7	351
0·077	22·2	8·9	0·007	2·0	0·8	0·610	175·7	70·8	1·038	298·9	120·4	352
0·467	205·7	82·1	0·002	1·0	0·4	1·300	572·7	228·6	0·651	287·0	114·5	353

Serial Number.	Names and strength.	Alcoholic strength. Vol. per cent.			Acidity.		
		Apparent.	True.	Percentage Obscuration.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.
1	2	3	4	5	6	7	8
354	Raisin spirit 63·0 U. P. ...	21·0	22·4	6·2	1·340	598·0	239·0
355	Toddy " 11·5 O. P. ...	62·6	63·4	1·3	1·998	315·1	125·9
356	" Cocoanut " 60·0 U. P. ..	23·8	24·2	1·6	1·218	503·3	201·1
357	" " " 25·0 " ...	42·9	43·4	1·1	0·792	182·5	73·0
358	" " " 25·0 " ...	42·6	42·8	0·5	0·750	175·2	70·0
359	" " " 40·0 " ...	34·8	35·2	1·1	1·710	486·0	194·0
360	Date spirit 61·9 " ...	22·4	22·8	1·7	1·218	534·2	213·1
361	" " 61·5 " ...	21·9	22·2	1·4	1·860	837·8	334·7
362	" " 54·8 " ...	26·2	26·8	2·2	1·980	738·8	295·5
363	" " 50·9 " ...	28·8	29·5	2·4	1·920	650·8	260·0
364	" " 55·8 " ...	26·1	26·3	0·8	1·200	456·3	182·2
365	" " 55·8 " ...	25·9	26·3	1·5	0·660	251·0	100·2
366	" " 50·5 " ...	29·4	30·2	2·6	1·350	447·0	178·6
367	" " 52·8 " ...	27·9	28·3	1·6	1·650	583·0	232·7
368	" " 59·1 " ...	24·0	24·3	1·2	1·50	617·2	246·5
369	" " 46·2 " ...	31·2	31·4	0·6	0·720	229·3	91·8
370	" " 64·3 " ...	20·3	20·7	1·9	1·770	855·0	341·3
371	" " 58·7 " ...	23·9	24·5	2·4	1·260	514·3	205·6
372	" " 45·6 " ...	31·0	32·7	5·2	1·620	495·4	198·3
373	Toddy Cocoanut " 11·5 O. P. ...	63·5	64·5	1·5	0·480	74·4	29·7
374	Toddy Wash	...	8·6	...	6·480	7534·9	3003·9
375	"	...	9·1	...	6·360	6989·0	2782·5
376	"	...	9·4	...	1·200	1276·6	512·2
377	Toddy spirit 60 U. P.	22·8	23·8	4·2	...	...	...
378	Toddy wash	...	15·6	...	...	...	...
379	Toddy spirit 25 U. P.	42·0	43·0	2·3	...	...	...
380	Rice " (outstill)	33·8	36·3	7·0	0·990	272·7	108·9
381	Raisin wash	...	7·2	...	...	...	...
382	" spirit 52·4 U. P.	28·1	29·4	2·4	...	...	...
383	Raisin wash	...	7·4	...	...	...	...
384	Raisin spirit 63·9 U. P.	21·0	22·1	5·0	...	...	...
385	Cocoanut Toddy spirit 11·5 O. P. ...	61·5	65·1	5·5	0·210	32·2	12·9
386	Rice Liquor	...	56·4	...	0·270	47·9	10·1
387	Millet Liquor	...	57·4	...	0·120	20·9	8·3
388	Date spirit 25·0 U. P.	42·5	44·4	4·3	0·556	125·2	9·1

ALDEHYDES.			FURFURAL.			FUSEL OIL AS AMYL ALCOHOL.			ETHERS.			
Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Serial Number.
9	10	11	12	13	14	15	16	17	18	19	20	
0·106	47·3	19·0	0·008	3·5	1·5	0·971	433·5	173·4	0·282	125·9	50·4	354
0·091	14·3	5·7	0·011	1·7	0·7	0·251	39·6	15·8	3·027	477·4	190·5	355
0·021	8·7	3·5	0·001	0·4	0·2	0·185	76·5	30·5	0·862	352·0	142·3	356
0·044	10·1	4·0	0·004	0·9	0·4	0·177	40·8	16·3	1·566	360·8	144·2	357
Nil	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	0·273	63·7	25·5	0·220	51·4	20·5	358
Nil	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	0·581	165·1	66·0	1·100	312·5	124·8	359
0·073	32·0	12·7	0·024	10·5	4·2	0·874	383·3	152·9	0·246	107·9	43·0	360
0·051	23·0	9·2	0·026	11·7	4·7	0 422	190·1	76·0	0·220	99·1	39·6	361
0·031	11·6	4·6	0·024	9·0	3·6	0·370	138·1	55·2	0·660	246·3	98·5	362
0·026	8·8	3·5	0·016	5·4	2·1	0·202	68·5	27·3	0·616	208·8	83·4	363
0·034	12·9	5·1	0·023	8·7	3·5	0·396	150·5	60·1	1·628	619·0	247·2	364
0·053	20·1	8·0	0·018	6·8	2·7	0·827	314·4	125·6	1·320	501·9	200·4	365
0·057	18·8	0·7	0·020	6·6	2·6	0·642	212·5	84·9	0·748	247·6	98·9	366
0·104	36·7	14·7	0·014	5·0	2·0	0·810	286·2	114 3	1·188	420·0	167·7	367
0·062	25·5	10·2	0·024	9·9	4·0	0·422	173·7	69·3	0·088	36·2	14·5	368
0·081	25·8	10·3	0·064	20·4	8·1	0·581	185·0	74·0	0·704	224·2	89·8	369
0·042	20·3	8·1	0·016	7·7	3·1	0·836	404·0	161·2	0·220	106·2	42·4	370
0·056	23·0	9·1	0·016	6·5	2·6	0·273	111·4	44·5	0·484	200·0	80·0	371
0·140	42·8	17·1	0·023	7·0	2·8	0·422	129·0	51·6	0·264	80·7	32·3	372
0·084	13·0	5·3	0·008	1·2	0·5	1·012	156·9	62·7	1·716	266·0	106·4	373
0·023	26·7	10·7	*Nil*	*Nil*	*Nil*	1·100	1279·0	509·9	1·496	1739·5	693·5	374
0·019	20·9	8·3	*Nil*	*Nil*	*Nil*	1·091	119·9	477·3	1·364	1498·9	596·7	375
Nil	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	...	...	...	...	...	...	376
U. t.	U. t.	U. t.	*Nil*	*Nil*	*Nil*	...	...	...	...	...	...	377
U. t.	U. t.	U. t.	*Nil*	*Nil*	*Nil*	...	...	...	...	...	...	378
U. t.	U. t.	U. t.	*Nil*	*Nil*	*Nil*	...	...	...	...	...	...	379
0·154	42·4	16·9	0·002	0·5	0·2	0·880	242·4	96·8	0·704	193·9	77·4	380
U. t.	U. t.	U. t.	*Nil*	*Nil*	*Nil*	...	...	...	...	...	...	381
0·019	6·5	2·6	0·003	1·0	0·4	...	...	...	...	...	...	382
U. t.	U. t.	U. t.	*Nil*	*Nil*	*Nil*	...	...	...	...	...	...	383
0·114	51·6	20·6	0·011	5·0	2·0	...	...	...	...	...	...	384
. s. t.	V. s. t.	V. s. t.	V. s. t.	V. s. t.	V. s. t.	0·774	118·9	47·5	2·420	371·7	148·6	385
0·121	21·4	8·5	*Nil*	*Nil*	*Nil*	1·338	237·2	94·6	0·704	124·8	49·7	386
0·128	22·3	8·9	*Nil*	*Nil*	*Nil*	1·700	296·1	118·4	1·452	252·9	101·1	387
0·109	24·5	9·9	0·035	7·9	3·2	1·233	277·7	112·0	0·193	43·5	17·5	388

NOTE.—U. t. = Unreadable trace.
V. s. t. = Very slight trace.

Serial Number.	Names and strength.	Alcoholic strength. Vol. per cent.			Acidity.		
		Apparent.	True.	Percentage obscuration.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.
1	2	3	4	5	6	7	8
	RICE, RAISINS, DATE AND TODDY						
389	Toddy spirit 25·0 U. P.	42·4	43·4	2·3	0·743	171·1	68·4
390	Raisin „ 22·5 „	44·4	44·6	0·4	0·300	65·4	26·1
391	Date „ 26·3 „	42·3	43·0	1·6	0·382	89·2	35·6
392	Raisin „ 25·0 „	42·8	44·0	2·7	0·540	122·7	49·0
393	„ „ 27·2 „	41·7	42·6	2·1	1·110	260·6	104·1
394	„ „ 43·0 „	32·6	33·0	1·2	0·690	209·1	83·6
395	„ „ 24·2 „	43·3	44·0	1·6	0·750	170·4	68·2
396	„ „ 25·8 „	42·9	43·4	1·2	0·450	103·6	41·4
397	Date „ 19·8 „	46·0	46·2	0·5	0·750	162·3	64·9
398	„ „ 18·3 „	46·4	47·4	2·3	0·570	120·3	48·1
399	„ „ 19·8 „	45·8	45·8	*Nil*	0·930	203·0	81·0
400	„ „ 21·3 „	46·0	46·4	0·8	0·630	135·8	54·2
401	„ „ 16·9 „	48·1	48·2	0·2	0·960	200·0	80·0
402	„ „ 19·4 „	46·3	47·0	1·5	0·270	57·4	22·9
403	„ „ 18·7 „	46·7	47·8	2·3	0·720	150·6	60·2
404	„ „ 19·5 „	46·2	47·0	1·7	0·570	121·3	48·5
405	„ „ 18·8 „	46·5	46·8	0·6	0·150	32·0	12·8
406	„ „ 18·8 „	46·8	47·0	0·4	0·930	200·0	80·0
407	„ „ 19·2 „	46·2	47·2	2·1	0·510	108·0	43·2
408	„ „ 19·6 „	46·2	47·2	2·1	0·690	146·2	58·4
	RICE, RAISINS, DATE AND TODDY						
409	Date spirit 60·2 U. P.	23·1	23·6	2·1	1·038	440·1	176·5
410	Raisin „ 60·0 „	23·1	23·6	2·1	0·704	298·3	119·0
411	Date „ 43·1 „	32·8	33·8	3·0	0·840	248·5	99·3
412	„ „ 56·8 „	25·1	26·0	3·5	1·440	553·9	221·0
	RICE, RAISINS, DATE AND TODDY						
413	Raisin spirit 27·0 U. P.	39·2	43·8	10·5	0·326	74·4	29·6
414	Date „ 24·3 „	42·9	42·9	*Nil*	0·500	116·5	46·6
415	„ „ 19·5 „	45·8	47·0	2·5	0·480	102·1	40·8
416	„ „ 20·0 „	46·0	47·0	2·1	0·450	95·7	38·3
	CANE-GUR, DATE-GUR, DATE-CHITTA AND CANE HEATED, SINGLE						
417	Gur spirit 44·0 U. P.	...	30·4	...	0·357	117·4	46·8
418	Date-gur spirit 15·0 U. P.	50·2	52·3	4·0	1·682	321·6	128·5
419	„ „ 20·0 „	47·2	47·8	1·3	2·673	559·2	222·7
420	„ „ 30·0 „	38·1	46·3	17·7	1·917	414·0	165·6

<table>
<tr><th colspan="3">ALDEHYDES.</th><th colspan="3">FURFURAL.</th><th colspan="3">FUSEL OIL AS AMYL ALCOHOL.</th><th colspan="3">ETHERS.</th><th rowspan="2">Serial Number.</th></tr>
<tr><th>Grams per litre.</th><th>Milligrams per 100 c. c. of absolute alcohol.</th><th>Grains per proof gallon.</th><th>Grams per litre.</th><th>Milligrams per 100 c.c. of absolute alcohol.</th><th>Grains per proof gallon.</th><th>Grams per litre.</th><th>Milligrams per 100 c.c. of absolute alcohol.</th><th>Grains per proof gallon.</th><th>Grams per litre.</th><th>Milligrams per 100 c. c. of absolute alcohol.</th><th>Grains per proof gallon.</th></tr>
<tr><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td><td></td></tr>
<tr><td colspan="13">SPIRITS, ETC., FIRE-HEATED, DOUBLE DISTILLATION.</td></tr>
<tr><td>0·062</td><td>14·2</td><td>5·7</td><td><i>Nil</i></td><td><i>Nil</i></td><td><i>Nil</i></td><td>1·450</td><td>334·1</td><td>133·5</td><td>0·334</td><td>76·9</td><td>30·7</td><td>389</td></tr>
<tr><td>0·195</td><td>43·5</td><td>17·5</td><td>0·021</td><td>4·7</td><td>1·9</td><td>0·898</td><td>201·3</td><td>80·6</td><td>0·282</td><td>61·4</td><td>24·5</td><td>390</td></tr>
<tr><td>0·113</td><td>26·3</td><td>10·5</td><td>0·044</td><td>10·2</td><td>4·1</td><td>0·742</td><td>173·4</td><td>69·0</td><td>0·194</td><td>45·3</td><td>18·1</td><td>391</td></tr>
<tr><td>0·136</td><td>31·0</td><td>12·4</td><td>0·024</td><td>5·5</td><td>2·2</td><td>1·496</td><td>340·0</td><td>137·0</td><td>1·012</td><td>230·0</td><td>92·0</td><td>392</td></tr>
<tr><td>0·134</td><td>31·4</td><td>12·6</td><td>0·027</td><td>6·3</td><td>2·5</td><td>1·865</td><td>437·8</td><td>175·0</td><td>0·132</td><td>31·0</td><td>12·4</td><td>393</td></tr>
<tr><td>0·067</td><td>20·3</td><td>8·1</td><td>0·032</td><td>9·7</td><td>3·9</td><td>0·748</td><td>226·4</td><td>90·6</td><td>1·232</td><td>373·3</td><td>149·1</td><td>394</td></tr>
<tr><td>0·132</td><td>30·0</td><td>12·0</td><td>0·046</td><td>10·4</td><td>4·2</td><td>1·522</td><td>346·0</td><td>138·4</td><td>0·308</td><td>70·0</td><td>28·0</td><td>395</td></tr>
<tr><td>0·181</td><td>41·7</td><td>16·6</td><td>0·010</td><td>2·3</td><td>0·9</td><td>1·276</td><td>294·0</td><td>117·5</td><td>0·870</td><td>200·2</td><td>80·0</td><td>396</td></tr>
<tr><td>0·050</td><td>10·8</td><td>4·3</td><td>0·058</td><td>12·5</td><td>5·0</td><td>0·660</td><td>143·0</td><td>57·0</td><td>1·452</td><td>314·3</td><td>125·5</td><td>397</td></tr>
<tr><td>0·062</td><td>13·2</td><td>5·2</td><td>0·038</td><td>8·0</td><td>3·2</td><td>0·493</td><td>104·0</td><td>41·6</td><td>0·484</td><td>102·1</td><td>40·8</td><td>398</td></tr>
<tr><td>0·074</td><td>16·1</td><td>6·4</td><td>0·031</td><td>6·7</td><td>2·7</td><td>0·590</td><td>128·8</td><td>51·4</td><td>0·846</td><td>184·7</td><td>73·7</td><td>399</td></tr>
<tr><td><i>Nil</i></td><td><i>Nil</i></td><td><i>Nil</i></td><td>0·039</td><td>8·4</td><td>3·3</td><td>0·810</td><td>174·5</td><td>69·7</td><td>1·364</td><td>293·9</td><td>117·4</td><td>400</td></tr>
<tr><td>0·049</td><td>10·2</td><td>4·1</td><td>0·038</td><td>7·9</td><td>3·1</td><td>1·065</td><td>221·0</td><td>88·3</td><td>0·968</td><td>200·8</td><td>80·3</td><td>401</td></tr>
<tr><td>0·083</td><td>17·7</td><td>7·0</td><td>0·027</td><td>5·7</td><td>2·2</td><td>0·616</td><td>131·0</td><td>52·4</td><td>0·352</td><td>74·8</td><td>29·9</td><td>402</td></tr>
<tr><td>0·075</td><td>15·7</td><td>6·3</td><td>0·019</td><td>4·0</td><td>1·6</td><td>0·739</td><td>154·6</td><td>61·8</td><td>0·484</td><td>101·3</td><td>40·5</td><td>403</td></tr>
<tr><td><i>Nil</i></td><td><i>Nil</i></td><td><i>Nil</i></td><td>0·032</td><td>6·8</td><td>2·7</td><td>0·810</td><td>172·3</td><td>68·8</td><td>0·308</td><td>65·5</td><td>26·2</td><td>404</td></tr>
<tr><td>0·138</td><td>29·5</td><td>11·8</td><td>0·061</td><td>13·0</td><td>5·2</td><td>1·364</td><td>291·4</td><td>116·4</td><td>0·520</td><td>111·1</td><td>44·4</td><td>405</td></tr>
<tr><td>0·114</td><td>24·3</td><td>9·7</td><td>0·020</td><td>4·2</td><td>1·7</td><td>0·669</td><td>142·3</td><td>57·0</td><td>0·520</td><td>110·6</td><td>44·2</td><td>406</td></tr>
<tr><td>0·064</td><td>13·5</td><td>5·4</td><td>0·015</td><td>3·2</td><td>1·2</td><td>0·660</td><td>140·0</td><td>56·0</td><td>0·308</td><td>65·2</td><td>26·0</td><td>407</td></tr>
<tr><td>0·160</td><td>34·0</td><td>13·5</td><td>0·030</td><td>6·4</td><td>2·5</td><td>1·452</td><td>307·6</td><td>123·0</td><td>0·484</td><td>102·5</td><td>41·0</td><td>408</td></tr>
<tr><td colspan="13">SPIRITS, ETC., STEAM-HEATED, SINGLE DISTILLATION.</td></tr>
<tr><td>0·102</td><td>43·2</td><td>17·3</td><td>0·051</td><td>21·6</td><td>8·7</td><td>1·200</td><td>508·8</td><td>204·0</td><td>1·074</td><td>455·4</td><td>182·6</td><td>409</td></tr>
<tr><td>0·376</td><td>159·3</td><td>63·6</td><td>0·016</td><td>6·8</td><td>2·7</td><td>0·870</td><td>368·6</td><td>147·1</td><td>0·246</td><td>104·2</td><td>41·6</td><td>410</td></tr>
<tr><td>0·017</td><td>5·0</td><td>2·0</td><td>0·045</td><td>13·3</td><td>5·3</td><td>0·827</td><td>244·7</td><td>97·8</td><td>0·572</td><td>169·2</td><td>67·6</td><td>411</td></tr>
<tr><td>0·057</td><td>22·0</td><td>8·8</td><td>0·073</td><td>28·1</td><td>11·2</td><td>0·326</td><td>125·4</td><td>50·0</td><td>0·352</td><td>135·4</td><td>54·0</td><td>412</td></tr>
<tr><td colspan="13">SPIRITS, ETC., STEAM-HEATED, DOUBLE DISTILLATION.</td></tr>
<tr><td>0·13</td><td>23·5</td><td>9·3</td><td>0·012</td><td>2·7</td><td>1·1</td><td>0·343</td><td>78·4</td><td>31·2</td><td>0·229</td><td>52·3</td><td>20·9</td><td>413</td></tr>
<tr><td>0·084</td><td>19·6</td><td>7·8</td><td>0·093</td><td>21·7</td><td>8·7</td><td>0·590</td><td>135·5</td><td>55·0</td><td>0·422</td><td>98·3</td><td>39·3</td><td>414</td></tr>
<tr><td>0·133</td><td>28·3</td><td>11·3</td><td>0·051</td><td>10·8</td><td>4·3</td><td>0·669</td><td>142·3</td><td>57·0</td><td>0·352</td><td>75·0</td><td>30·0</td><td>415</td></tr>
<tr><td>0·118</td><td>25·1</td><td>10·0</td><td>0·064</td><td>13·4</td><td>5·3</td><td>0·440</td><td>93·6</td><td>37·4</td><td>0·352</td><td>75·0</td><td>30·0</td><td>416</td></tr>
<tr><td colspan="13">-GUR, MOLASSES-SHIRA, AND JAGGERY SPIRITS: FIRE-DISTILLATION.</td></tr>
<tr><td>0·130</td><td>42·8</td><td>17·0</td><td><i>Nil</i></td><td><i>Nil</i></td><td><i>Nil</i></td><td>1·332</td><td>430·2</td><td>174·5</td><td>0·493</td><td>162·2</td><td>64·6</td><td>417</td></tr>
<tr><td>0·052</td><td>10·0</td><td>4·0</td><td>0·007</td><td>1·3</td><td>0·5</td><td>0·431</td><td>82·4</td><td>32·9</td><td>0·686</td><td>131·2</td><td>52·4</td><td>418</td></tr>
<tr><td>0·105</td><td>21·9</td><td>8·7</td><td>0·019</td><td>3·9</td><td>1·5</td><td>1·261</td><td>263·8</td><td>105·0</td><td>1·426</td><td>29·8</td><td>118·8</td><td>419</td></tr>
<tr><td>0·179</td><td>38·7</td><td>15·5</td><td>0·013</td><td>2·8</td><td>1·1</td><td>1·400</td><td>302·4</td><td>121·0</td><td>0·440</td><td>95·0</td><td>38·0</td><td>420</td></tr>
</table>

Serial Number.	Names and strength.	ALCOHOLIC STRENGTH. VOL. PER CENT.			ACIDITY.		
		Apparent.	True.	Percentage obscuration.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.
1	2	3	4	5	6	7	8
421	Date gur spirit 40·0 U. P.	33·4	42·7	21·8	4·042	946·6	377·6
422	Jaggery spirit 59·6 „	23·2	23·8	2·5	0·985	413·8	165·3
423	„ „ 47·0 „	30·7	32·0	4·1	0·696	217·2	87·0
424	Gur „ 15·0 „	48·6	49·0	0·8	0·564	115·1	46·0
425	„ „ 25·0 „	42·9	44·7	4·0	1·872	422·6	168·9
426	„ „ L. P. „	57·8	58·0	0·3	0·696	120·0	48·3
427	Molasses „ 17·0 „	45·7	47·8	4·8	1·986	419·0	167·5
428	Shira „ 25·7 „	42·6	45·0	5·3	1·656	368·0	146·9
429	Gur „ 40·0 „	35·3	37·0	4·6	3·264	882·1	352·6
430	„ „ 30·0 „	40·4	41·6	2·9	1·554	373·6	149·4
431	„ „ 20·0 „	45·5	46·2	1·5	1·620	850·7	140·0
432	Palm jaggery spirit 29·6 U. P.	41·1	41·1	*Nil*	0·832	202·4	80·9
433	„ „ „ 14·7 „	48·8	49·0	0·4	0·774	158·0	63·1
434	Cane and palm-jaggery spirit 30·4 U. P. ...	40·8	41·1	0·7	1·032	251·1	100·3
435	„ „ „ „ „ 1·2 „ ...	56·6	57·2	1·0	0·666	116·4	46·5
436	Shira spirit 23·4 U. P.	43·8	44·6	1·8	0·972	217·9	87·0
437	„ „ L. P.	56·5	56·9	0·7	0·678	119·1	47·6
438	„ „ 1·8 O. P.	57·6	58·6	1·7	0·405	69·1	27·6
439	„ „ 23·5 U.	42·8	44·2	3·2	0·426	96·4	38·5
440	„ „ 24·8 „	42·7	43·2	1·6	1·050	243·6	97·4
441	„ „ 0·5 O. P.	56·9	57·6	1·2	1·068	185·4	74·1
442	Date-gur spirit 30·0 U. P.	40·2	42·4	5·2	2·040	504·9	201·4
443	Shira spirit (Bombay Still) ... 25·2 U. P.	43·2	45·6	5·3	1·534	348·7	139·5
444	„ „ ... ... 24·4 „	43·7	44·6	2·0	0·842	188·8	75·6
445	„ „ ... ... 1·0 O. P.	57·6	58·4	1·4	1·669	285·7	114·1
446	„ „ ... ... 23·7 „	44·1	44·6	1·1	1·586	355·6	142·3
447	„ „ ... ... 24·7 „	43·4	43·6	0·5	2·470	565·5	225·4
448	„ „ ... ... Proof	57·9	58·8	1·5	1·500	255·1	101·8
449	„ „ ... ... U. P.	43·1	43·7	1·4	2·382	545·1	217·4
450	Chitta-and cane-gur spirit ... 10·0 U. P.	51·6	52·8	2·3	2·322	437·9	175·7
451	Gur spirit „ ... 30·0 „	41·3	41·4	0·2	2·205	532·6	212·6
452	Chitta and cane-gur „ ... 50·0 „	30·1	30·2	0·3	2·745	909·0	362·5
453	Date-Chitta „ ... 17·4 „	47·6	51·4	7·4	1·260	245·1	98·0
454	Date-Chitta and cane-gur spirit ... 27·3 „	41·5	43·8	5·2	1·860	424·7	169·8
455	Shira „ ... 25·5 „	43·9	44·2	0·7	2·400	543·0	217·1
456	„ „ ... 1·4 „	56·8	57·0	0·3	2·094	367·4	146·6
457	Gur „ ... 5·0 „	54·3	54·4	0·2	0·900	165·4	66·0

ALDEHYDES.			FURFURAL.			FUSEL OIL AS AMYL ALCOHOL.			ETHERS.			
Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Serial Number.
9	10	11	12	13	14	15	16	17	18	19	20	
0·164	38·6	15·3	0·026	6·1	2·4	0·449	105·1	41·9	0·651	152·5	60·8	421
0·128	53·8	21·5	0·010	4·2	1·6	1·550	651·0	260·0	0·229	96·2	38·4	422
0·069	2·2	8·6	0·008	2·5	1·0	0·942	294·4	117·7	0·114	35·6	14·2	423
0·066	13·5	5·4	0·009	1·8	0·7	0·858	175·1	70·0	0·316	64·5	25·8	424
0·091	20·5	8·2	0·011	2·5	1·0	0·456	103·0	41·0	0·616	139·0	55·6	425
0·040	6·9	2·8	0·008	1·4	0·6	0·471	81·2	32·6	0·862	148·6	60·0	426
0·150	31·6	12·6	0·074	15·6	6·2	0·364	76·8	30·6	0·524	110·5	44·2	427
0·060	13·3	5·3	0·006	1·3	0·5	0·326	72·4	29·0	1·179	261·8	104·6	428
0·116	31·3	12·5	0·027	7·3	2·9	0·478	129·2	51·6	0·827	223·5	89·3	429
0·128	30·8	12·3	0·021	5·0	2·0	0·646	155·3	62·1	0·528	126·9	50·8	430
0·135	29·2	11·7	0·020	4·3	1·7	0·159	34·2	13·7	0·528	114·3	45·6	431
0·056	13·6	5·4	0·014	2·6	1·0	0·418	101·7	40·7	1·496	364·0	143·5	432
0·055	11·2	4·5	0·008	1·6	0·6	1·224	249·8	99·8	1·250	255·1	102·0	433
0·103	25·0	10·0	0·021	5·1	2·0	0·486	118·2	47·2	0·458	111·1	44·5	434
0·068	11·9	4·7	0·099	17·6	7·0	0·950	166·1	66·4	0·704	123·1	49·2	435
0·037	8·3	3·3	0·009	2·0	0·8	1·231	276·0	110·2	0·580	130·0	51·9	436
0·295	13·0	5·2	0·008	1·6	0·6	0·471	82·8	33·1	1·425	250·4	100·2	437
0·059	10·1	4·0	0·015	2·5	1·0	0·190	32·4	13·0	1·179	201·2	80·3	438
0·030	6·8	2·7	0·014	3·1	1·2	0·152	34·4	13·7	0·756	171·0	68·4	439
0·054	12·5	5·0	0·026	6·0	2·2	0·152	35·3	14·1	0·458	106·0	42·5	440
0·078	13·5	5·4	0·030	5·2	2·1	0·152	26·4	10·5	0·510	88·5	35·4	441
0·097	24·0	9·5	0·022	5·4	2·1	0·456	112·9	45·0	0·580	143·5	57·2	442
0·048	10·9	4·4	0·017	4·0	1·6	0·229	52·0	20·8	0·634	144·1	57·6	443
0·068	15·3	6·1	0·012	2·7	1·1	0·114	25·6	10·2	0·176	39·5	15·8	444
0·032	5·5	2·2	0·012	2·1	0·8	0·291	50·0	20·0	0·704	120·5	48·3	445
0·024	5·4	2·2	0·007	1·6	0·6	0·273	61·2	24·5	1·144	256·5	102·7	446
0·036	8·5	3·3	0·006	1·4	0·5	0·309	70·6	28·2	0·899	206·2	82·1	447
0·035	6·0	2·4	0·015	2·6	1·0	0·088	15·0	5·9	0·898	152·7	61·0	448
0·017	4·0	1·6	0·016	3·7	1·5	0·069	15·8	6·3	0·598	136·8	54·6	449
0·025	4·7	1·9	0·009	1·7	0 7	0·529	100·2	40·0	2·596	491·7	196·4	450
0·030	7·4	2·9	0·008	1·9	0·8	0·458	110·6	44·1	1·188	289·1	114·5	451
0·027	9·0	3·7	0·011	3·6	1·5	0·185	61·2	24·4	1·444	478·0	190·7	452
0·056	10·9	4·4	0·037	7·4	2·9	0·538	104·7	41·8	0·246	48·0	19·1	453
0·092	21·0	8·4	0·069	15·8	6·5	0·405	92·5	37·0	0·404	92·2	36·9	454
0·041	9·3	3·7	0·016	3·6	1·4	0·299	67·6	27·0	0·475	107·5	43·0	455
0·054	9·4	3·8	0·012	2·1	0·8	0·573	100·5	40·2	0·844	148·0	59·1	456
0·068	12·5	5·0	0·028	5·2	2·1	0·423	77·7	31·0	1·390	255·5	102·0	457

Serial Number.	Name and strength.	Alcoholic Strength. Vol. per cent.			Acidity.		
		Apparent.	True.	Percentage obscuration.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.
1	2	3	4	5	6	7	8
458	Gur spirit ... 45·0 U. P.	31·6	32·7	3·4	2·022	618·3	247·0
459	Shira ,, ... 1·0 O. P.	57·8	58·2	0·7	1·272	216·8	87·3
460	,, ,, ... 24·0 U. P.	43·6	44·4	1·8	1·596	359·4	143·8
461	Cane gur ,, ... 25·1 ,,	43·3	44·2	2·0	1·842	416·7	166·6
462	Gur ,, ... 20·0 ,,	46·4	46·6	0·4	1·062	227·9	91·1
463	,, ,, ... 50·0 ,,	30·0	30·5	1·8	1·272	417·0	166·7
464	,, ,, ... 68·0 ,,	17·9	18·5	3·2	1·200	648·6	259·3
465	,, ,, ... 86·0 ,,	8·5	9·0	5·5	0·444	493·4	198·6
466	,, ,, ... 25·0 ,,	44·2	44·2	*Nil*	0·780	176·4	70·5
467	,, ,, ... 49·0 ,,	30·0	30·6	1·9	2·190	715·7	286·0
468	,, ,, ... 1·4 ,,	56·9	57·0	0·2	0·900	158·0	63·1
469	Shira ,, ... 1·8 O. P.	57·4	58·8	2·4	0·510	86·7	34·6
470	Date gur ,, ... 30·0 U. P.	40·2	42·4	5·2	1·920	452·8	180·9
471	Shira Spirit (Bombay still) 25·2 ,,	43·2	45·6	5·2	1·770	388·1	154·9
472	Cane-chitta wash ——	...	7·2	...	1·200	1666·6	661·4
473	,, ,, spirit ... 3·0 U. P.	55·2	55·4	0·3	...	...	...
474	Cane-chitta, spirit ... 49·0 ,,	29·4	30·2	2·6	...	...	...
475	,, ,, ... 15·0 ,,	49·2	50·0	1·6	...	...	...
476	,, ,, ... 25·0 ,,	43·0	44·0	2·3	...	...	...
477	Gur-spirit ... ... 65·2 ,,	19·1	19·1	*Nil.*	...	...	...
478	,, wash ... ... ——	...	10·6	...	...	...	...
479	,, -spirit ... ... 65·2 U. P.	19·8	20·0	1·0	...	...	...
480	,, ,, ... 65·2 ,,	19·8	21·4	7·4	...	...	...
481	,, wash ... ... ——	...	8·7	...	2·160	3000·0	1194·1
482	,, -spirit ... ... 25·5 U. P.	42·7	43·6	2·1	0·750	268·4	68·7
483	Chitta and gur-spirit ... ... 17·0 ,,	46·7	47·0	0·6	1·380	293·6	117·3
484	Gur-spirit (outstill)	36·9	38·0	2·1	1·020	268·4	107·2
485	Cane-gur, spirit experimental still	57·2	58·8	2·7	0·480	81·6	32·6
486	,, ,, 2·0 U. P. ...	55·9	57·8	3·3	0·330	57·1	22·8
487	Shira-spirit 1·8 P.O.	53·2	55·0	3·2	0·510	92·7	37·0
488	Date-Gur spirit 30·0 U. P.	38·7	41·4	6·5	2·250	543·4	216·9
489	Shira-spirit (Bombay still) 25·2 U. P. ...	40·8	40·8	*Nil.*	2·040	500·0	199·4
490	Gur- ,, ——	64·8	67·6	4·1	1·170	173·0	69·1
491	Molasses spirit 5·2 U. P.	53·5	54·0	0·9	0·210	38·8	15·5
492	,, ,, 36·5 ,, ...	37·1	37·6	1·3	0·330	87·7	35·1
	CANE GUR, DATE-GUR, DATE-CHITTA AND CANE-GUR,						
493	Gur-spirit 2·5 U. P.	54·5	55·4	1·7	0·847	152·8	61·0

Aldehydes.			Furfural.			Fusel oil as Amyl Alcohol.			Ethers.			
Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Serial Number.
9	10	11	12	13	14	15	16	17	18	19	20	
0·021	6·4	2·5	0·007	2·2	0·9	0·132	40·3	16·1	0·598	183·0	73·0	458
0·084	14·4	5·8	0·016	2·7	1·1	0·767	131·8	52·6	0·228	39·2	15·6	459
0·052	11·7	4·7	0·015	3·4	1·4	0·052	11·7	4·7	0·123	27·7	11·1	460
0·051	11·5	4·6	0·009	2·0	0·8	0·334	75·5	30·2	0·792	179·0	71·6	461
0·098	21·0	8·4	0·070	15·0	6·0	1·614	346·4	138·5	0·123	26·4	10·6	462
0·037	12·1	4·7	0·049	16·0	6·4	0·194	63·6	25·4	1·408	461·6	184·6	463
Nil	*Nil*	*Nil*	0·039	21·1	8·4	0·088	47·6	19·0	1·478	799·0	319·0	464
0·019	21·0	8·5	*Nil*	*Nil*	*Nil*	0·150	167·2	66·8	0·035	38·9	15·6	465
0·039	8·8	3·5	*Nil*	*Nil*	*Nil*	0·519	117·4	46·9	0·580	131·2	52·5	466
Nil	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	0·229	74·8	30·0	0·396	129·4	51·7	467
Nil	*Nil*	*Nil*	0·018	3·1	1·3	0·750	131·6	52·6	0·572	100·3	40·1	468
0·071	12·1	4·8	0·013	2·2	0·9	1·223	208·0	83·0	1·320	224·4	89·6	469
0·101	23·8	9·5	0·013	3·0	1·2	1·118	263·7	105·3	0·616	145·3	58·0	470
0·110	2·4	0·9	0·016	3·5	1·4	1·188	260·5	103·9	0·660	144·7	57·7	471
0·077	106·9	42·4	0·001	1·4	0·6	0·273	379·1	150·5	0·396	550·0	218·2	472
0·166	29·9	11·9	0·012	2·2	0·9	...	...	...	...	...	...	473
U. t.	U. t.	U. t.	0·021	6·9	2·8	...	...	...	...	...	...	474
0·114	22·8	9·1	0·008	1·6	0·6	...	...	...	...	...	...	475
0·088	20·0	7·9	0·013	2·9	1·2	...	...	...	...	...	...	476
0·027	14·1	5·7	0·011	5·8	2·3	...	...	...	...	...	...	477
U. t.	U. t.	U. t.	0.001	0·9	0·4	...	...	...	...	...	...	478
0·013	6·5	2·6	0·008	4·0	1·6	...	...	...	...	...	...	479
0·016	7·9	3·0	0·009	4·2	1·7	...	...	...	...	...	...	480
Nil.	*Nil.*	*Nil.*	0·001	1·1	0·5	0·484	556·7	221·4	0·132	151·7	60·4	481
0·115	26·3	10·5	0·006	1·3	0·5	0·783	179·5	71·7	0·968	219·7	88·6	482
0·192	40·8	16·3	0·015	3·2	1·3	1·505	320·2	128·0	0·660	140·4	56·1	483
0·114	30·0	11·9	0·001	0·3	0·1	0·845	222·4	88·8	0·748	196·8	78·6	484
V. s. t.	V. s. t.	V. s. t.	Tr.	Tr.	Tr.	1·470	250·0	99·9	1·716	291·8	116·6	485
V. s. t.	V. s. t.	V. s. t.	*Nil.*	*Nil.*	*Nil.*	1·513	261·8	104·6	0·616	106·6	42·6	486
V. s. t.	V. s. t.	V. s. t.	0·006	1·1	0·4	0·704	128·0	51·1	1·012	184·0	73·4	487
V. s. t.	V. s. t.	V. s. t.	0·006	1·4	0·6	1·522	367·6	146·7	1·056	255·0	101·8	488
V. s. t.	V. s. t.	V. s. t.	0·007	1·7	0·7	1·206	295·6	117·9	0·660	161·7	64·5	489
V. s. t.	V. s. t.	V. s. t.	*Nil.*	*Nil.*	*Nil.*	1·038	153·5	61·3	0·968	143·2	57·1	490
0·148	27·4	10·9	*Nil.*	*Nil.*	*Nil.*	1·420	262·9	104·8	0·264	48·8	19·5	491
0·032	8·5	3·4	0·004	1·0	0·4	0·317	84·3	33·7	0·088	23·4	9·3	492

MOLASSES, SHIRA AND JAGGERY SPIRITS: FIRE-HEATED, DOUBLE DISTILLATION.

0·111	20·0	8·0	0·012	2·1	0·8	1·634	294·9	117·7	0·264	47·6	19·0	493

Note.—V. s. t. = Very slight trace.
U. t. = Unreadable trace.
Tr. = Trace.

Serial Number.	Names and Strength.	ALCOHOLIC STRENGTH. VOL. PER CENT.			ACIDITY.		
		Apparent.	True.	Percentage obscuration	Grams per litre.	Milligrams per 100 c. c. of absolute alcohol.	Grains per proof gallon.
1	2	3	4	5	6	7	8
494	Jaggery spirit 17·6 U. P.	46·2	47·7	2·0	0·272	57·0	22·8
495	Shira „ 0·9 „	58·3	59·1	1·5	0·762	129·1	51·4
	CANE-GUR, DATE-GUR, DATE-CHITTA AND CANE GUR,						
496	Gur-spirit 65·0 U. P.	19·3	21·0	8·1	13·350	6557·1	2332·5
497	Gur „ 65·0 „ with special rectifying arrangement.	18·8	19·8	5·0	13·305	6719·6	2739·2
498	Jaggery spirit 53·7 „	26·2	27·4	4·4	0·913	333·2	133·1
	CANE GUR, DATE-GUR, DATE-CHITTA AND CANE-GUR						
499	Jaggery spirit 19·2 U. P.	45·0	45·7	1·5	0·248	54·3	21·7
500	„ „ 59·4 „	24·0	24·0	*Nil.*	...	...	...
501	„ wash	...	10·4	...	...	...	...
502	„ „	...	9·1	...	...	...	...
	MISCELLANEOUS SPIRITS						
503	Mahua and Aniseed 25·0 U. P. ...	43·3	43·8	1·1	0·192	43·8	17·5
504	Lapat spirit* 25·0 „ ...	42·6	42·8	0·5	0·603	140·9	56·3
505	Aniseed spirit 25·0 „ ...	42·8	43·8	1·3	0·561	128·1	51·2
506	Cardamom spirit 27·0 „ ...	41·4	42·6	2·9	0·140	32·8	13·1
507	Coriander spirit 25·0 „ ...	42·8	44·0	2·5	0·411	93·4	37·4
508	Ginger spirit 25·0 „ ...	43·0	44·4	3·2	0·712	160·4	64·1
509	Orange spirit 25·0 „ ...	42·8	43·4	1·3	0·644	148·4	59·3
510	Rose „ 25·0 „ ...	42·8	44·4	3·6	0·134	30·2	12·1
511	Aniseed „ 24·5 „ ...	43·1	43·4	0·7	3·036	699·5	279·6
512	Spiced „ 23·4 „ ...	42·6	44·0	3·2	4·212	957·3	382·9
513	„ „ 25·0 „ ...	43·5	44·2	1·6	0·258	58·4	23·2
514	„ „ 24·5 „ ...	43·6	44·6	2·2	2·550	571·7	228·8
515	Mahua and mundi† spirit 24·5 „ ...	43·8	44·4	1·3	1·050	236·5	94·5
516	Aniseed „ 25·2 „ ...	42·5	43·5	2·3	0·972	223·4	91·1
517	Shira and spiced „ 24·3 „ ...	42·8	42·8	*Nil*	1·497	350·5	140·0
518	Flavoured Mahua „ 25·0 „ ...	43·8	44·0	0·5	0·582	132·3	52·9
519	Mahua and Aniseed „ 20·0 „ ...	46·2	46·6	0·9	0·852	182·8	74·0
520	Molasses „ Nim‡ „ 5·6 „ ...	53·3	54·0	1·3	0·492	91·1	36·3
521	„ „ Cardamom „ 35·6 „ ...	36·9	37·8	2·4	0·540	142·8	56·7
522	„ „ Chowarki§ „ 6·5 „ ...	53·7	54·8	2·0	0·354	64·5	25·8
523	„ „ Orange „ 35·7 „ ...	36·9	37·0	0·3	0·678	183·2	73·2
524	„ „ Mango „ 5·5 „ ...	54·4	54·6	0·4	0·310	55·0	22·0

Foot-notes.—* Lapat is made with a mixture of rose-petals and *mahua.*

† *Mundi* (Sphœranthus Indica *Linn.*) a plant with bitter, pungent stomachic properties.

‡ Nim (Melia Azadirachta, *Linn.*)

§ Chowarki made with orange-peel, Cumin seed (Cuminum Cyminum, *Linn*), aniseed and dried peppermint.

ALDEHYDES.			FURFURAL.			FUSEL OIL AS AMYL ALCOHOL.			ETHERS.			
Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Serial Number.
9	10	11	12	13	14	15	16	17	18	19	20	
0·095	19·9	7·9	0·009	1·9	0·7	1·470	309·0	123·0	0·246	51·6	20·6	494
0·103	17·4	6·9	*Tr.*	*Tr.*	*Tr.*	0·387	65·5	26·1	0·792	134·0	53·4	495

OLASSES, SHIRA AND JAGGERY SPIRITS: STEAM-HEATED, NGLE DISTILLATION.

0·091	43·3	17·3	0·009	4·3	1·7	0·344	163·8	65·3	0·334	159·0	63·4	496
0·109	55·0	22·4	0·006	3·0	1·2	0·354	178·7	72·8	0·361	182·3	74·3	497
0·091	33·2	13·3	0·007	2·6	1·0	0·918	335·0	133·9	0·387	141·2	56·4	498

OLASSES, SHIRA AND JAGGERY: STEAM-HEATED, DOUBLE STILLATION.

0·020	4·4	1·7	0·010	2·2	0·9	0·528	115·5	46·2	0·387	84·7	33·8	499
0·042	17·5	7·0	0·007	2·9	1·1	...	...	...	...	...	...	500
il.	*Nil.*	*Nil.*	*Nil.*	*Nil.*	*Nil.*	...	...	...	...	...	...	501
il.	*Nil.*	*Nil.*	*Nil.*	*Nil.*	*Nil.*	...	...	...	...	...	...	502

., SPICED, FLAVOURED, ETC).

·113	25·8	10·3	0·039	9·0	3·6	0·748	170·8	68·3	0·281	64·1	25·7	503
·096	22·4	8·8	0·040	9·3	3·7	1·109	259·1	103·5	0·228	53·3	21·3	504
·118	26·9	10·8	0·063	14·4	5·8	0·757	172·8	69·1	0·193	44·0	17·6	505
·058	13·6	5·5	0·063	14·8	5·8	1·004	235·7	94·2	0·211	49·5	20·0	506
·039	8·8	3·6	0·091	20·7	8·3	1·120	254·5	101·8	0·264	60·0	24·0	507
·094	21·2	8·5	0·054	12·2	5·0	1·654	372·5	149·0	0·387	87·4	35·0	508
·123	28·3	11·3	0·074	17·0	6·8	0·668	154·0	61·5	0·140	32·2	13·0	509
·132	29·7	12·0	0·058	13·0	5·2	0·547	123·2	49·3	0·220	49·5	19·8	510
·148	34·1	13·6	0·055	12·7	5·0	1·110	255·8	102·2	1·316	303·2	121·2	511
·098	22·3	8·9	0·070	15·8	6·4	0·144	32·7	13·1	1·036	280·9	112·3	512
·085	19·2	7·7	0·014	3·2	1·3	0·243	54·9	21·9	0·475	107·5	42·9	513
·156	34·9	14·0	0·083	18·6	7·4	0·775	173·8	69·5	2·402	538·6	215·5	514
·117	26·3	10·5	0·028	6·3	2·5	1·299	292·6	116·8	1·214	273·4	109·2	515
·238	54·7	21·9	0·078	17·9	7·1	0·486	111·7	44·7	1·478	339·8	135·8	516
0·021	5·0	2·0	0·006	1·4	0·6	0·106	24·8	9·9	1·267	296·0	118·4	517
0·088	20·0	8·0	0·065	15·0	6·0	0·626	142·3	57·0	0·739	168·0	67·2	518
0·053	11·4	4·6	0·031	6·7	2·7	0·996	213·7	86·5	0·387	83·0	33·6	519
0·119	22·0	8·7	0·006	1·1	0·4	1·111	205·7	8·1	0·369	68·3	27·2	520
0·056	14·8	5·3	0·008	2·1	0·8	0·132	34·9	13·8	0·264	69·8	27·7	521
0·068	12·4	4·9	0·007	1·2	0·5	0·670	122·2	48·8	0·299	54·5	21·8	522
0·055	14·8	5·9	0·004	1·0	0·4	0·344	92·9	37·1	0·264	71·3	28·5	523
0·024	4·4	1·7	0·022	4·0	1·6	0·660	112·0	45·0	0·176	32·2	12·9	524

Serial Number.	Names and strength.	Alcoholic Strength: Vol. per cent.			Acidity.		
		Apparent.	True.	Percentage Obscuration.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.
1	2	3	4	5	6	7	8
525	Molasses and Aniseed spirit 5·0 U. P. ...	54·8	55·6	1·4	0·510	91·7	36·7
526	,, ,, Cardamom ,, 5·0 ,, ...	53·9	53·9	*Nil*	0·270	51·9	20·0
527	,, ,, Motia* ,, 4·6 ,, ...	53·3	54·6	2·4	0·392	71·7	28·6
528	,, ,, Aniseed ,, 4·8 ,, ...	54·2	54·8	1·1	0·270	49·2	19·6
529	,, ,, Khaskhas† ,, 5·1 ,, ...	54·6	55·2	1·1	0·420	76·0	30·4
530	,, ,, Rose ,, 35·8 ,, ...	37·9	39·0	2·8	0·660	169·2	67·6
531	,, ,, Orange ,, 4·9 ,, ...	54·2	54·4	0·4	0·216	39·7	15·8
532	,, and Rose ,, 4·7 ,, ...	53·0	53·5	0·9	0·426	79·6	31·8
533	Ginger spirit 23·9 ,, ...	43·4	43·8	0·9	0·210	48·0	19·0
534	Spirit with Lime 24·8 ,, ...	43·5	44·8	2·9	0·120	29·0	10·7
535	,, without Lime 25·0 ,, ...	44·0	45·0	2·2	1·830	406·6	162·1
536	Country Arrack	40·1	41·2	2·6	...	...	...
537	Mossumbie‡ spirit, steam-heated	5·6	38·2	85·3	0·600	157·0	62·6
538	Rose ,, ,, ...	5·0	38·6	87·0	0·240	62·1	24·8
539	Cardamom ,, ,, ...	6·2	39·0	84·1	0·540	138·5	55·3
540	Red Masalla (*i.e.*, spiced)	6·0	38·5	84·4	0·330	85·7	34·3
541	Superior quality Cardamom spirit, steam-heated	6·9	38·8	82·2	0·450	114·9	46·3
542	,, Mossumbie ,, ,, ...	11·3	39·7	71·5	0·480	120·9	48·3
543	,, Red Masalla ,, ,, ...	6·6	38·8	82·7	0·330	85·0	33·9
544	,, Rose ,, ,, ...	8·8	38·5	77·1	0·150	38·9	15·6
545	Outstill liquor 88·4 U. P. ...	6·6	7·6	13·2	...	...	...
546	,, 87·3 ,, ...	7·2	7·7	6·5	...	...	...
547	,, 72·5 ,, ...	15·7	18·4	14·7	...	...	...
548	,, —— (3 years' old) ...	14·6	16·7	12·6	2·220	1329·3	530·4
549	,, 93·9 ,, ...	3·5	7·2	51·4	...	...	...
550	,, 88·3 ,, ...	6·7	7·6	11·8	...	...	...
551	,, 88·8 ,, ...	6·4	8·4	23·8	...	...	...
552	,, 88·9 ,, ...	6·3	7·2	12·5	...	...	...
553	,, 89·1 ,, ...	6·2	7·2	13·9	...	...	...
554	,, 90·0 ,, ...	5·7	5·9	3·4	...	...	...
555	,, 90·4 ,, ...	5·5	8·3	33·7	...	...	...
556	,, 90·5 ,, ...	5·4	6·3	14·3	...	...	...
557	,, 91·0 ,, ...	5·2	6·4	18·7	...	...	...
558	,, 91·2 ,, ...	5·0	6·3	20·6	...	...	...
559	Bangla Liquor (Assam)	27·6	28·9	4·5	1·680	581·3	232·4
560	Phul Liquor— (ditto)	26·8	27·9	3·9	1·980	709·6	284·0
561	Country Arrack	39·9	41·0	2·9	0·120	29·2	11·6
562	,, spirit	54·7	55·9	2·2	0·840	150·0	60·0

Notes.—* Motia flowers (a species of Jasmine).
† Khas-khas (Andropogon Muricatus, *Retz.*)
‡ Mossumbie is sweet lemon.

ALDEHYDES.			FURFURAL.			FUSEL OIL AS AMYL ALCOHOL.			ETHERS.			
Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 *c.c.* of absolute alcohol.	Grains per proof gallon.	Serial Number.
9	10	11	12	13	14	15	16	17	18	19	20	
0·055	9·9	3·9	0·013	2·3	0·9	0·546	98·3	39·2	1·443	259·5	103·8	525
0·023	4·2	1·6	0·006	1·1	0·4	0·748	133·7	55·4	0·334	61·9	24·7	526
Nil.	*Nil.*	*Nil.*	0·018	3·3	1·3	0·739	135·3	54·0	0·334	61·1	24·4	527
0·082	15·0	5·9	0·007	1·2	0·5	0·935	170·6	68·1	0·352	64·2	25·6	528
0·083	15·0	6·0	0·006	1·0	0·4	1·120	202·8	81·0	0·484	87·6	35·0	529
0·077	19·7	7·8	0·006	1·5	0·6	0·529	135·6	54·2	0·132	33·8	13·5	530
0·128	23·5	9·3	0·004	0·7	0·3	0·915	168·1	67·1	0·158	29·0	11·6	531
0·148	27·6	11·0	0·008	1·5	0·6	0·669	125·0	49·9	0·017	3·2	1·3	532
0·020	4·5	1·8	0·039	9·0	3·6	1·153	263·2	105·2	*Nil.*	*Nil.*	*Nil.*	533
0·075	16·7	6·7	*Nil.*	*Nil.*	*Nil.*	0·343	76·5	30·6	0·440	98·2	39·3	534
Nil.	*Nil.*	*Nil.*	0·012	2·6	1·0	0·185	41·1	16·3	0·968	215·1	85·7	535
U. t.	U. t.	U. t.	0·012	2·9	1·2	...	...	...	...	...	...	536
0·064	16·8	6·7	0·011	3·0	1·2	0·695	181·9	72·6	1·144	299·5	119·5	537
0·082	21·3	8·5	0·014	3·6	1·4	0·528	136·8	54·6	1·100	284·9	113·7	538
0·082	21·0	8·4	0·025	6·4	2·6	0·660	169·2	67·6	1·408	361·0	144·3	539
0·070	18·4	7·3	0·022	5·7	2·3	0·607	157·7	63·0	0·308	80·0	32·0	540
0·059	15·2	6·1	0·023	6·0	2·4	0·475	122·4	48·9	1·584	408·2	163·0	541
0·061	15·4	6·2	0·014	3·5	1·4	0·660	166·2	66·5	1·628	410·1	163·9	542
0·081	20·9	8·3	0·031	8·0	3·2	0·546	140·7	56·2	0·308	79·4	31·7	543
0·057	14·8	5·9	0·023	6·0	2·4	0·554	143·1	57·5	0·880	228·6	91·4	544
...	...	...	...	...	...	...	...	...	...	...	...	545
...	...	...	...	...	...	...	...	...	...	...	...	546
...	...	...	...	...	...	...	...	...	...	...	...	547
0·038	22·7	9·1	0·003	1·8	0·7	0·255	152·7	60·9	0·616	368·8	147·1	548
...	...	...	...	...	...	...	...	...	...	...	...	549
...	...	...	...	...	...	...	...	...	...	...	...	550
...	...	...	...	...	...	...	...	...	...	...	...	551
...	...	...	...	...	...	...	...	...	...	...	...	552
...	...	...	...	...	...	...	...	...	...	...	...	553
...	...	...	...	...	...	...	...	...	...	...	...	554
...	...	...	...	...	...	...	...	...	...	...	...	555
...	...	...	...	...	...	...	...	...	...	...	...	556
...	...	...	...	...	...	...	...	...	...	...	...	557
...	...	...	...	...	...	...	...	...	...	...	...	558
0·055	19·0	7·6	0·014	4·9	1·9	0·352	121·8	48·7	0·440	152·2	60·8	559
0·056	20·1	8·0	0·004	1·5	0·6	0·502	179·9	72·0	0·924	331·2	132·5	560
U. t.	U. t.	U. t.	U. t.	U. t.	U. t.	0·475	115·8	46·2	0·352	85·8	34·2	561
0·075	13·4	5·3	V. s. t.	V. s. t.	V. s. t.	1·589	284·2	113·5	0·572	102·3	40·8	562

Note.—U. t. = Unreadable trace.
V. s. t. = Very slight trace.

Serial Number.	Names and strength.	Alcoholic strength. Vol. per cent. Apparent.	Alcoholic strength. Vol. per cent. True.	Alcoholic strength. Vol. per cent. Percentage Obscuration.	Acidity. Grams per litre.	Acidity. Milligrams per 100 c.c. of absolute alcohol.	Acidity. Grains per proof gallon.
1	2	3	4	5	6		8
		NATIVE STATES AND OTHER FOREIGN.					
563	Single Distilled spirit	19·3	21·3	9·4	1·721	807·9	326·5
564	Double „ „	39·9	47·3	15·2	1·343	281·8	149·2
565	Rum	40·3	42·0	4·0	1·043	248·3	99·2
566	Spiced spirit	32·2	39·3	18·1	0·821	208·9	94·8
567	Mahua with Amla*	24·3	24·6	1·2	0·591	240·2	96·0
568	„ without „	17·4	18·6	6·4	0·603	323·7	129·4
569	Rum	48·0	49·8	3·6	0·210	42·0	16·8

* Amla is the astringent fruit of *Phyllanthus Emblica.*

(NOT EUROPEAN) SPIRITS.

ALDEHYDES.			FURFURAL.			FUSEL OIL AS AMYL. ALCOHOL.			ETHERS.			
Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Serial number.
9	10	11	12	13	14	15	16	17	18	19	20	
0·132	61·9	25·0	0·016	7·5	3·0	1·444	677·9	273·9	0·088	41·3	16·7	563
0·168	35·5	18·7	0·029	6·1	3·2	1·553	328·3	172·6	0·915	193·2	101·7	564
0·202	48·1	19·2	0·021	5·0	2·0	1·273	303·1	121·1	0·282	67·1	26·8	565
0·187	47·6	21·6	0·020	5·1	2·3	1·586	403·6	183·2	0·827	210·4	95·5	566
0·125	50·8	20·3	0·017	6·9	2·8	0·999	406·1	162·2	0·211	85·8	34·3	567
0·028	15·2	6·0	0·019	10·2	4·1	1·350	724·7	289·9	0·211	113·2	45·3	568
V. s. t.	V. s. t.	V. s. t.	*Nil*	*Nil*	*Nil*	0·722	144·9	57·9	1·144	229·7	91·8	569

Note.—V. s. t. = Very slight trace.

STATEMENT B.

RESULTS OF ANALYSIS

OF

FERMENTED LIQUORS:

I.—Imported Beers;

II.—Beers Brewed in the Hills;

III.—Beers Brewed in the Plains;

IV.—Miscellaneous;

V.—Pachwai and other rice beers;

VI.—Toddies.

STATEMENT

Results of Analysis

Serial No.	Name.	ALCOHOLIC STRENGTH.		ACIDITY.			ALDEHYDES.		
		Under proof.*	True strength in volume per cent.	Grams per litre.	Mgms. per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Mgms. per 100. c.c. of absolute alcohol.	Grains per proof gallon.
1	2	3	4	5	6	7	8	9	10
							I.—IMPORTED		
1	Pale ale	89·6	5·9	0·180	305·1	121·1	0·023	38·9	15·5
2	Extra Stout (Beer)	89·9	5·8	0·210	362·1	145·5	0·019	32·7	13·1
3	Superior Lager Beer	89·2	5·9	0·180	305·1	116·6	0·017	28·8	11·0
4	Extra Stout	86·4	7·7	0·510	662·3	262·5	0·012	15·6	6·1
5	Light Pale ale	87·8	6·9	0·150	217·4	86·0	0·031	43·5	17·8
6	Bier	90·7	5·3	0·090	170·0	67·7	v. s. t.	v. s. t.	v. s. t.
7	Helles Bier	91·9	4·6	0·060	130·4	51·8	„	„	„
8	Hoch Bier	90·3	5·6	0·060	107·1	43·3	„	„	„
9	Export Bier	91·2	5·0	0·090	180·0	71·6	Unr. tr.	Unr. tr.	Unr. tr.
10	Pale ale	86·9	7·5	0·360	480·0	192·4	0·042	56·0	22·4
11	Pilsener Bier	92·5	4·3	0·180	418·6	168·0	0·016	37·2	14·9
					II.—BEERS BREWED				
12	Nilgiri ale	87·6	7·1	0·240	338·0	135·5	Tr.	Tr.	Tr.
13	Beer	84·2	9·0	0·150	166·6	66·5	Tr.	„	„
14	Native ale	83·7	9·3	0·210	225·8	90·2	0·028	30·1	12·0
15	Native Beer	83·7	9·3	0·150	161·3	64·4	0·031	33·3	13·3
16	Native Beer	83·9	9·2	0·240	260·9	104·3	0·015	16·3	6·5
17	English ale	87·7	7·0	0·150	214·3	85·3	0·033	47·1	18·8
18	English Pale ale	88·5	6·5	0·210	323·7	127·8	0·055	84·6	33·4
19	Pale ale	86·6	7·7	0·540	701·3	282·1	0·060	77·9	31·3
20	Ale	88·7	6·5	0·480	738·5	297·3	0·035	53·8	21·7
21	Pale ale	89·7	5·9	0·300	508·5	203·9	0·042	71·2	28·5
22	Beer	90·1	5·6	0·120	214·3	84·8	0·035	62·5	24·8
23	Beer	90·0	5·7	0·360	631·6	252·0	v. s. t.	v. s. t.	v. s. t.
24	Ale	87·8	6·9	0·180	260·9	103·3	„	„	„
25	Beer	88·9	6·3	0·240	380·9	151·3	0·053	84·1	33·4
26	Stout ale	91·7	4·7	0·150	319·1	126·5	0·072	153·2	60·7
27	Pale ale	88·1	6·8	0·180	264·7	105·9	v. s. t.	v. s. t.	v. s. t.
28	Amber ale	89·1	6·2	0·150	241·9	96·3	„	„	„
29	Tavern ale	84·9	8·6	0·480	558·1	222·5	0·019	22·1	8·8
30	Pale ale	88·7	6·5	0·420	646·1	260·1	0·066	101·5	40·9
31	Stout	90·0	5·7	0·270	473·7	189·0	0·029	50·9	20·3
32	Native ale	83·3	9·5	0·300	315·8	125·7	0·031	32·6	13·0

NOTE.—Un. tr. or u. t. = ... Unreadable trace.
V. s. t. = ... Very slight trace.
Tr. = ... Trace.

* Given in proof terms for the convenience of those accustomed only to use such.

B.

of Fermented Liquors.

FURFURAL.			FUSEL OIL AS AMYL ALCOHOL.			ETHERS.			PERCENTAGES (STRICTLY, GRAMS PER 100 C. C.)			
Grams per litre.	Mgms. per 100 c c of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Mgms. per 100 c c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Mgms. per 100 c. c. of absolute alcohol.	Grains per proof gallon.	Sugars, per cent	Albuminoids per cent.	Total solids, per cent.	Serial Number.
11	12	13	14	15	16	17	18	19	20	21	22	23
BEERS.												
Nil.	*Nil.*	*Nil.*	0·466	789·8	313·6	0·220	372·9	148·0	*Nil.*	0·44	2·60	1
Unr. tr.	Unr. tr.	Unr. tr.	0·414	713·8	286·9	0·044	75·8	30·5	0·07	1·75	3·37	2
Nil.	*Nil.*	*Nil.*	0·400	678·0	259·1	0·088	149·1	57·0	0·47	0·31	2·90	3
Unr. tr.	Unr. tr.	Unr. tr.	0·704	914·3	362·3	0·122	171·4	67·9	1·00	0·62	6·52	4
Nil.	*Nil.*	*Nil.*	0·106	153·6	60·8	0·044	63·8	25·2	0·24	1·25	3·28	5
"	"	"	0·123	232·1	92·6	*Nil.*	*Nil.*	*Nil.*	0·47	0·31	4·84	6
"	"	"	0·106	230·4	91·6	"	"	"	0·19	0·75	4·70	7
"	"	"	0·088	157·1	63·5	"	"	"	0·43	0·87	3·72	8
"	"	"	0·501	1,002·0	398·5	0·132	264·0	105·0	0·42	0·26	5·84	9
"	"	"	0·185	246·6	99·0	0·176	234·6	94·0	0·66	0·44	3·05	10
"	"	"	1·267	2,946·5	1182·5	0·044	102·3	41·0	0·81	0·68	4·48	11
IN THE HILLS.												
Nil.	*Nil.*	*Nil.*	0·247	343·0	139·4	0·088	124·0	49·7	0·62	...	3·41	12
"	"	"	0·343	381·1	152·0	0·220	244·4	97·5	1·01	...	4·00	13
"	"	"	0·185	198·9	79·4	0·132	141·9	56·7	0·65	...	2·78	14
"	"	"	0·158	169·9	67·8	0·30	32·2	12·9	...	...	...	15
Nil.	*Nil.*	*Nil.*	0·150	163·0	65·2	0·132	143·8	57·3	...	...	...	16
"	"	"	0·106	151·4	60·3	0·044	62·8	25·0	...	...	...	17
"	"	"	0·097	149·2	59·0	0·044	67·7	26·8	...	...	...	18
"	"	"	0·255	331·2	133·2	0·132	171·4	69·0	0·64	0·44	4·01	19
"	"	"	0·616	947·7	381·5	0·088	135·4	54·5	0·49	0·44	...	20
"	"	"	0·317	537·3	215·4	*Nil*	...	...	0·90	*Nil*	...	21
"	"	"	0·132	235·7	93·3	0·044	78·6	21·1	0·89	0·87	4·86	22
"	"	"	0·338	592·9	236·6	0·066	115·8	46·2	0·89	0.44	4·86	23
"	"	"	0·326	472·4	187·0	0·088	127·5	50·5	0·74	0·87	...	24
"	"	"	0·502	796·8	316·6	0·132	209·5	83·2	0·44	0·44	4·69	25
"	"	"	0·387	823·4	326·4	0·088	187·2	74·2	1·08	1·31	7·60	26
"	"	"	0·308	452·9	181·2	0·396	582·3	232·9	0·69	0·44	5·13	27
"	"	"	0·308	496·7	197·8	0·088	141·9	56·5	0·47	0·44	4·81	28
"	"	"	0·422	490·7	195·6	*Nil*	*Nil.*	*Nil.*	0·80	0·44	...	29
"	"	"	0·466	716·9	288·6	"	"	"	0·24	0·87	...	30
"	"	"	0·352	617·5	246·4	1·628	2856·1	1139·6	2·65	0·66	...	31
"	"	"	0·343	361·0	143·7	0·132	138·9	55·3	0·76	0·66	...	32

STATEMENT

Results of Analysis

Serial No.	Name.	Alcoholic Strength.		Acidity.			Aldehydes.		
		Under proof.*	True strength in volume per cent.	Grams per litre.	Mgms. per 100 c c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Mgms. per 100 c. c. of absolute alcohol.	Grains per proof gallon.
1	2	3	4	5	6	7	8	9	10
					BEERS BREWED IN				
33	English ale	88·4	6·6	0·390	590·9	235·3	0·031	46·9	18·7
34	Continental Pale (English) ale ...	90·7	5·3	0·360	679·3	270·9	0·053	100·0	40·0
35	Pale ale	88·0	6·9	0·180	260·9	105·0	0·053	76·8	30·9
36	India Pale ale	88·5	6·5	0·120	184·6	73·0	v. s. t.	v. s. t.	v. s. t.
					III.—BEERS BREWED				
37	Common Native ale	79·7	11·6	1·500	1,293·1	517·2	0·027	23·3	9·3
38	Malt Native ale	81·8	10·4	0·840	807·7	323·1	0·207	200·0	79·6
39	Indian Pilsener	85·5	8·3	0·450	542·2	217·2	0·135	162·7	65·2
40	Pale ale	84·3	9 0	0·450	500·0	200·0	0·090	100·0	40·0
41	XXX Stout	87·7	7·0	0·300	428·6	170·7	0·059	84·3	33·6
42	Native ale	84·7	8·7	0·360	413·8	164 7	0·048	55·2	22·0
43	Native ale	85·5	8·3	0·420	506·0	202·8	0·034	40·0	16·4
44	Country Beer	84·4	8·9	0·360	404·5	161·5	0·029	32·6	13·0
45	Country Hops Beer	84·4	8·9	0·450	505·6	201·9	0·125	140·4	56·1
46	Country Malt Beer	84·0	9·1	1·020	1120·9	446·2	0·046	50·5	20·1
47	Pale ale	88·4	6·6	0·390	590·9	235·3	0·019	28·8	11·4
48	Country Beer	83·1	9·6	0·450	468·7	186·3	*Nil.*	*Nil.*	*Nil.*
49	India Pale ale	88·9	6·3	0·450	714·3	283·8	0·139	220·6	87·7
50	East India Pale ale	87·4	7·2	0·150	208·3	83·3	v. s. t.	v. s. t.	v. s. t.
51	XXX Stout	90·7	5·3	0·150	283·0	112·9	”	”	”
52	Ordinary ale	88·1	6·8	0·240	352·9	141·1	0·074	108·8	43·5
53	Ale	88·9	6·3	0·150	238·1	94·6	0·074	117·4	46·7
54	Porter	90·6	5·4	0·240	444·4	178·7	0·074	137·0	55·1
55	Beer	88·5	6·5	0·270	415·4	164·4	0·079	121·5	48·1
56	Ordinary ale	91·1	5·1	0·090	176·4	70·7	v. s. t.	v. s. t.	v. s. t.
57	Stout ale	90·3	5·5	0·180	327·3	129·9	0·065	118·1	46·9
58	Beer	88·9	6·3	0·210	333·3	132·4	0·129	204·7	81·3
59	English ale	85·5	8·3	0·150	180·7	72·4	0·050	60·2	24·1
60	“Good Native” ale	83·7	9·3	0·180	193·5	77·2	0·042	45·1	18·0
61	Ordinary Native ale	82·7	9·9	0·330	333·3	133·5	v. s. t.	v. s. t.	v. s. t.
62	Native ale	85·8	8 1	0·540	666·6	266·2	0·038	46·9	18·7
63	Native ale	84·2	9·0	0·300	333·3	132·9	0·030	33·3	13·3
64	Beer	91·4	4·9	0·270	551·0	219·8	0·040	81·6	32·5

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* Given in proof terms for the convenience of those accustomed only to use such.

B—*contd.*

of Fermented Liquors.

Furfural.			Fusel oil as amyl alcohol.			Ethers.			Percentages (strictly, grams per 100 c. c.)			
Grams per litre.	Mgms. per 100 c. c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Mgms. per 100 c. c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Mgms. per 100 c. c. of absolute alcohol.	Grains per proof gallon.	Sugars, per cent.	Albuminoids per cent.	Total solids per cent.	Serial Number.
11	12	13	14	15	16	17	18	19	20	21	22	23
THE HILLS—(*contd.*)												
Nil.	*Nil.*	*Nil.*	0·211	319·7	127·3	0·088	133·3	53·1	0·70	0·87	...	33
v. s. t.	v. s. t.	v. s. t.	0·326	615·1	245·3	*Nil.*	...	...	3·05	*Nil.*	...	34
Nil.	*Nil.*	*Nil.*	0·361	523·2	210·6	0·088	127·5	51·3	0·59	0·44	3·35	35
”	”	”	0·299	460·0	182·0	*Nil.*	...	...	0·89	0·87	4·44	36
IN THE PLAINS.												
Nil	*Nil.*	*Nil.*	0·554	477·1	191·0	0·308	265·5	106·2	1·00	0·31	2·52	37
”	”	”	0·238	228·8	91·5	*Nil.*	...	...	0·46	0·31	2·43	38
”	”	”	0·343	413·3	165·6	”	...	...	0·35	0·94	2·66	39
”	”	”	0·106	117·8	47·3	”	...	...	0·43	0·31	3·04	40
”	”	”	0·123	175·7	70·0	0·088	125·7	50·0	0·60	0·62	5·00	41
”	”	”	0·255	293·1	116·7	0·088	101·1	40·3	1·24	1·25	2·50	42
”	”	”	0·440	530·1	212·4	*Nil.*	...	...	0·32	0·62	1·73	43
”	”	”	1·011	1,135·9	·453·6	0·044	49·4	19·7	0·37	*Nil.*	...	44
0·014	15·7	6·2	1·847	2,075·2	828·8	0·088	98·8	39·5	0·59	*Nil.*	...	45
Nil.	*Nil.*	*Nil.*	0·476	523·8	208·2	0·044	48·3	19·2	0·51	0·44	...	46
”	”	”	0·625	946·9	377·1	0·044	66·6	26·6	1·46	*Nil.*	...	47
”	”	”	0·282	293·7	116·6	0·088	91·6	36·4	0·31	...	...	48
”	”	”	0·370	587·3	233·3	0·088	139·7	55·5	0·39	0·87	3·30	49
”	”	”	0·405	562·5	225·0	0·044	61·1	24·4	0·43	0·44	3·64	50
”	”	”	0·220	415·1	165·6	0·044	83·0	33·1	0·54	1·31	6·32	51
”	”	”	0·405	595·6	238·2	*Nil.*	...	...	0·67	0·44	4·67	52
”	”	”	0·449	712·7	283·1	0·088	139·7	55·5	0·07	0·44	4·18	53
”	”	”	0·194	359·3	144·5	*Nil.*	...	...	0·58	0·87	5·29	54
”	”	”	0·405	623·1	246·5	0·044	67·7	26·8	0·76	0·44	4·70	55
”	”	”	0·273	535·3	214·7	0·132	258·8	103·8	0·62	*Nil.*	3·04	56
”	”	”	0·176	320·0	127·0	0·088	160·0	63·5	0·74	0·44	4·83	57
”	”	”	0·361	573·0	227·7	*Nil.*	...	...	1·18	0·66	3·67	58
”	”	”	0·414	498·8	199·9	0·044	53·0	21·2	0·48	*Nil.*	3·40	59
”	”	”	0·405	435·5	173·9	*Nil.*	...	...	0·47	0·44	2·76	60
”	”	”	0·264	266·6	106·8	0·088	88·8	35·6	2·35	0·66	3·03	61
”	”	”	0·405	500·0	199·6	0·132	162·9	65·1	0·36	*Nil.*	1·92	62
”	”	”	0·326	362·2	144·4	0·088	97·8	38·9	*Nil.*	...	1·92	63
”	”	”	0·220	448·9	179·0	0·308	628·6	250·7	0·66	0·87	...	64

Note—V. s. t. = ... Very slight trace.

STATEME T

Results of Anal is

Serial No.	Name.	Alcoholic Strength. Under proof.†	Alcoholic Strength. True strength in volume per cent.	Acidity. Grams per litre.	Acidity. Mgms. per 100 c.c. of absolute alcohol.	Acidity. Grains per proof gallon.	Aldehydes. Grams per litre.	Aldehydes. Mgms. per 100 c.c. of absolute alcohol.	Aldehydes. Grains per proof
1	2	3	4	5	6	7	8	9	1
	BEERS BREWED								
65	Beer	91·1	5·1	0·300	588·2	235·9	0·042	82·3	
66	Native ale (Beer)	84·4	8·9	0·600	674·1	269·2	0·031	34·8	9
67	English ale (Beer)	89·1	6·2	0·360	580·6	231·2	0·033	53·2	2
	IV.—MAHUA, SOMA AND OTH R								
68	Sugda or boiled Mahua	84·7	8·7	0·480	551·7	219·6	0·024	27·6	9
69	Sur (Barley and Soma flower Beer) ...	88·7	6·5	3·78	581·5	234·1	U. tr.	U. tr.	U.
70	Robra (Barley and Soma flower Beer)...	85·0	8·5	1·260	1482·3	588·0	„	„	„
71	Hlawza (a special kind of rice beer) ...	75·0	14·3	0·330	230·8	92·4	V. s. t.	V. s. t.	V.
72	Scye (jaggri and certain roots) ...	75·2	14·2	0·270	190·1	76·2	*Nil.*	*Nil.*	*N*
73	Darbahra* No. I (Basis: Chota-Treacle	93·8	3·5	2·460	7028·6	2777·4	„	„	„
74	Darbahra No. II (Basis: Chota-Treacle)	94·0	3·4	1·710	5,029·4	1,995·0	*Nil.*	*Nil.*	*N*
75	„ „ III „ „	91·9	4·6	1·860	4,043·5	1,607·4	V. s. t.	V. s. t.	V.
76	„ „ IV „ „	93·9	3·5	1·290	3,685·7	1,480·3	*Nil.*	„	
77	„ „ V „ „	94·1	3·3	1·110	3·363·6	1,316·9	„	„	
78	Cholum	89·7	5·9	0·180	305·1	122·3	V. s. t.	V. s. t.	V. t.
	V.—PACHWAI AND OTH R								
79	Rice Beer	91·6	4·8	0·390	812·5	325·0	*Nil.*	*Nil.*	*N*
80	Pachwai	87·6	7·1	1·890	2661·9	1,066·9	V. s. t.	V. s. t.	V. t.
81	„	93·9	3·5	0·330	942·8	378·7	0·063	180·0	3
82	„	94·6	3·1	0·270	870·9	350·0	V. s. t.	V. s. t.	V. t.
83	Jand (Rice Beer)	89·2	6·2	0·480	774·2	311·1	s. t.	s. t.	s.
84	Lugri „	92·4	4·3	0·480	1116·3	442·1	„	„	
85	Sur „	85·5	8·3	0·630	759·0	304·1	V. s. t.	V. s. t.	V. t.
86	Dzu „	89·3	6·1	0·300	491·8	196·2	*Nil.*	*Nil.*	*N*
87	Rice Beer	71·1	16·5	0·570	345·4	138·0	V. s t.	V. s t.	V. t.
88	Pachwai	96·4	2·0	0·300	1,500·0	583·3	*Nil.*	*Nil.*	*N*
89	Rice Beer	72·7	15·6	0·390	250·0	100·0	V. s. t.	V. s. t.	V. t.
90	Rohi "Adulterated Pachwai" ...	83·3	9·5	0·780	821·0	326·9	„	„	
91	Kaung (Rice Beer)	84·7	8·7	0·960	1103·4	439·2	V. s. t.	V. s. t.	V. t.
92	Karen Rice Beer	75·8	13·8	0·480	347·8	138·8	„	„	
93	Akkiboja (Rice Beer)	92·8	4·1	0·480	1170·7	466·6	0·036	87·8	0
94	Jwan (Rice Beer)	13·8	13·8	1·230	891·3	355·8	0·035	25·3	1
95	Pachwai	95·4	2·6	0·360	1,384·6	547·8	0·065	250·0	9

* "Darbahra" is made from treacle and many varieties of herbs and essences.

† Given in proof terms for the convenience of those accustomed only to use such.

B —*contd.*

of Fermented Liquors.

FURFURAL.			FUSEL OIL AS AMYL. ALCOHOL.			ETHERS.			PERCENTAGES (STRICTLY, GRAMS PER 100 C. C.)		
Grams per litre.	Mgms. per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Mgms. per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Mgms. per 100 c. c. of absolute alcohol.	Grains per proof gallon.	Sugars per cent.	Albuminoids per cent.	Serial number.
11	12	13	14	15	16	17	18	19	20	21	22
THE PLAINS—(*contd.*)											
Nil.	*Nil.*	*Nil.*	0·114	223·5	89·6	0·088	172·5	69·2	0·81	0·44	65
„	„	„	0·167	187·6	74·9	0·132	148·3	59·2	0·56	*Nil.*	66
„	„	„	0·176	283·9	113·0	0·044	70·9	28·2	0·46	0·66	67
MISCELLANEOUS VARIETIES OF BEERS.											
U. Tr.	U. Tr.	U. Tr.	0·959	1102·3	438·8	0·132	151·7	60·4	2·19	0·87	68
„	„	„	1·214	1867·7	752·0	1·320	2030·7	817·7	*Nil.*	0·87	69
Nil.	*Nil.*	*Nil.*	1·126	1324·7	525·4	0·660	776·4	308·0	„	1·75	70
„	„	„	0·338	236·3	94·6	0·132	92·3	36·9	„	2·06	71
„	„	„	0·414	291·5	116·8	0·264	185·9	74·5	„	0·17	72
„	„	„	0·361	1031·4	407·6	0·176	502·8	198·7	0·31	*Nil.*	73
„	„	„	0·422	1241·1	492·3	0·088	258·8	102·6	1·28	0·09	74
„	„	„	0·502	1091·3	433·8	0·088	191·3	76·0	0·57	0·33	75
„	„	„	0·396	1131·4	454·4	0·088	251·4	100·9	*Nil.*	0·09	76
„	„	„	0·554	1678·8	657·3	0·088	266·6	104·4	0·52	0·16	77
„	„	„	0·695	1177·9	472·3	0·132	223·7	89·7	3·06	0·44	78
RICE BEERS.											
Nil.	*Nil.*	*Nil.*	0·405	843·8	337·5	0·044	91·7	36·6	*Nil.*	0·68	79
„	„	„	0·722	1016·9	407·6	0·520	732·4	293·5	„	...	80
„	„	„	0·238	680·0	273·9	0·520	1,485·6	596·7	„	...	81
„	„	„	0·730	2,354·8	946·3	0·176	567·7	228·1	„	*Nil.*	82
„	„	„	0·616	993·5	399·2	*Nil.*	...	...	*Nil.*	0·08	83
„	„	„	0·792	1,841·7	729·5	0·264	613·9	243·1	„	0·34	84
„	„	„	0·537	646·9	259·2	0·176	212·0	84·9	„	0·37	85
„	„	„	0·431	706·5	281·9	0·264	432·8	172·7	„	0·68	86
„	„	„	0·255	154·5	61·7	0·308	186·6	74·6	19·20	0·35	87
„	„	„	0·211	1,055·0	410·2	0·044	220·0	85·5	*Nil.*	0·34	88
Nil	*Nil.*	*Nil.*	0·308	197·4	78·9	0·308	197·4	78·9	*Nil.*	0·16	89
„	„	„	0·643	676·8	269·5	0·176	185·2	73·7	„	0·87	90
„	„	„	0·669	768·9	306·1	0·396	455·2	181·1	„	0·44	91
„	„	„	0·317	229·7	91·7	0·660	478·2	190·9	6·80	1·75	92
„	„	„	0·466	1,136·6	453·0	0·132	321·9	128·3	*Nil.*	0·87	93
„	„	„	0·431	312·3	124·7	0·660	478·2	190·9	„	1·31	94
„	„	„	0·299	1,150·0	455·0	0·132	507·7	200·9	„	0·44	95

Note.—V. S. T. = Very slight trace.
U. Tr. = Unreadable trace.
S. T. = Slight trace.

STATEMENT

Results of Analysis

Serial Number.	Name.	Alcoholic Strength.		Acidity.			Aldehydes.		
		Under proof.*	True strength in volume per cent.	Grams per litre.	Mgms. per 100 c. c. of absolute alcohol.	Grains per proof gallon.	Gams per litre.	Mgms. per 100 c. c. of absolute alcohol.	Grains per proof gallon.
1	2	3	4	5	6	7	8	9	10
	V.—PACHWAI AND OTHER								
96	Pachwai	95·4	2·6	0·090	346·1	136·9	V. s. t.	V. s. t.	V. s. t.
97	Pachwai	73·5	15·1	0·072	47·7	19·0	0·021	13·9	5·5
98	Pachwai	88·1	6·8	0·060	88·2	35·3	0·018	26·5	10·6
99	Pachwai	74·8	14·4	0·078	54·2	21·7	0·016	11·1	4·4
100	Pachwai	94·0	3·4	0·750	2,205·9	875·0	0·076	223·5	88·6
101	No. I Kaung (Rice Beer)	86·4	7·7	0·930	1,207·8	478·6	0·168	218·2	86·5
102	No. II „ „	92·0	4·6	0·660	1,434·7	577·5	0·114	247·8	99·7
	VI.—DIFFERENT								
103	Date toddy	60·9	22·4	1·920	8,57·1	343·7	V. s. t.	V. s. t.	V. s. t.
104	Palm Toddy	94·1	3·3	2·370	7,181·8	2,812·0	0·023	70·0	27·3
105	Date „	88·2	6·7	6·810	10,164·2	4,040·0	0·014	21·0	8·3
106	Date „	89·9	5·8	1·470	2,534·5	1,018·8	0·010	1·2	6·9
107	Date „	94·4	3·2	1·380	4,312·5	1,725·0	U. tr.	U. tr.	U. tr.
108	Palmyra Toddy	91·7	4·7	0·570	1,212·8	480·7	*Nil.*	*Nil*	*Nil*
109	Cocoanut „	91·7	4·7	1·560	3,319·1	1,315·6	...	...	...
110	Cocoanut „	91·1	5·1	1·380	2,705·9	1,085·4	0·060	117·6	47·2
111	Date „	92·5	4·3	2·070	4,813·9	1,932·0	*Nil.*	*Nil.*	*Nil.*
112	Palm tree Sendhi	92·5	4·3	0·990	2,302·3	924·0	„	„	„
113	Cocoanut Toddy	89·9	5·8	2·700	4,655·2	1,871·3	Tr.	Tr.	Tr.
114	Date „	94·9	2·9	0·600	2,068·9	823·5	V. s. t.	V. s. t.	V. s. t.
115	Cocoanut „	88·1	6·8	1·890	2779·4	1,111·8	„	„	„
116	Date „	95·2	2·7	1·020	3,777·7	1,487·5	*Nil.*	*Nil.*	*Nil.*
117	Date „	96·3	2·1	1·440	6,857·1	2,724·3	V. s. t.	V. s. t.	V. s. t.
118	Palmyra „	93·0	4·0	3·180	7,950·0	3,180·0	„	„	„
119	Date „	96·6	2·0	1·980	9,900·0	4,076·4	„	„	„
120	Palmyra	92·8	4·1	1·290	3,146·3	1,254·2	„	„	„
121	Palm juice	89·2	6·2	0·840	1,354·8	544·4	*Nil*	*Nil.*	*Nil.*
122	Date juice	92·9	4·0	0·810	2,025·0	798·6	„	„	„
123	Date toddy	93·8	3·5	2·820	8,057·1	3,183·8	„	„	„
124	Date „	99·4	0·3	0·990	33,000·0	11,550·0	„	„	„
125	Palm juice	93·5	3·7	0·870	2,351·3	936·9	V. s. t.	V. ..	V. s. t.
126	Cocoanut juice	89·9	5·8	3·330	5,741·4	2,307·9	„	„	„

* Given in proof terms for the convenience of those accustomed only to use such.

NOTE—V. s. t. = Very slight trace.

U. tr. = Unreadable trace.

B—*contd.*

of Fermented Liquors.

FURFURAL.			FUSEL OIL AS AMYL ALCOHOL.			ETHERS.			PERCENTAGES (STRICTLY, GRAMS PER 100 C.C.)			
Grams per litre.	Mgms. per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Mgms. per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Mgms. per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Sugars per cent.	Albuminoids per cent.	Total solids per cent.	Serial Number.
11	12	13	14	15	16	17	18	19	20	21	22	
RICE BEERS.—*(contd).*												
Nil.	*Nil.*	*Nil.*	0·273	1,050·0	415·4	0·308	1,184·6	468·7	*Nil.*	0·44	...	96
"	"	"	0·075	49·7	19·8	0·052	34·4	13·8	0·19	0·66	...	97
"	"	"	0·066	97·0	38·8	0·035	51·5	20·6	1·00	0·44	...	98
"	"	"	0·061	42·3	16·7	0·052	36·1	14·4	1·54	*Nil.*	...	99
"	"	"	0·361	1,061·3	421·1	0·264	776·5	308·0	2·27	0·44	...	100
"	"	"	0·510	662·3	262·5	0·352	457·1	181·1	*Nil.*	1·31	1·79	101
"	"	"	0·598	1,300·0	523·2	0·176	382·6	154·0	"	0·66	1·19	102
TODDIES												
Nil.	*Nil.*	*Nil.*	0·158	70·5	28·3	1·232	550·0	220·6	*Nil.*	*Nil*	...	103
"	"	"	0·282	854·5	334·6	3·256	9,866·7	3863·1	1·38	10·94	...	104
"	"	"	0·238	355·2	141·2	1·012	1,510·4	600·4	*Nil*	...	...	105
"	"	"	0·202	348·2	140·0	0·352	606·9	243·9	...	...	...	106
"	"	"	0·150	468·8	187·5	0·176	550·0	220·0	...	...	...	107
"	"	"	0·132	280·8	111·3	0·044	93·6	37·1	...	...	...	108
"	"	"	0·158	336·1	133·0	0·176	374·4	148·4	...	...	...	109
"	"	"	0·457	896·1	359·4	0·176	345·1	138·4	0·55	0·68	...	110
"	"	"	0·396	920·9	369·6	0·264	613·9	246·4	0·33	1·36	...	111
"	"	"	0·378	879·0	352·8	0·132	306·9	123·2	0·49	0·37	...	112
"	"	"	0·290	500·0	200·9	0·264	455·1	183·7	1·87	0·75	...	113
"	"	"	0·194	668·9	266·3	0·044	151·7	60·4	0·71	0·37	...	114
"	"	"	0·308	452·9	180·6	0.440	647·0	258·9	2·29	30·62	...	115
"	"	"	0·308	1,140·7	449·1	0·044	162·9	64·1	*Nil.*	...	...	116
"	"	"	0·185	880·9	350·0	0·088	419·0	166·5	...	...	...	117
"	"	"	0·634	1,585·0	634·0	0·044	110·0	44·0	...	...	...	118
"	"	"	0·326	1,630·0	671·2	0·220	1,100·0	452·9	...	...	...	119
"	"	"	0·282	687·8	274·2	0·264	643·9	256·6	...	...	...	120
"	"	"	0·361	582·2	233·9	0·176	283·9	114·0	...	...	...	121
"	"	"	0·546	1,365·0	538·3	0·220	550·0	216·9	...	...	...	122
"	"	"	0·528	1,508·6	596·1	0.342	977·1	386·1	...	...	...	123
"	"	"	0·343	1,1433·3	4,001·6	0·088	2,933·3	1,026·6	...	...	...	124
"	"	"	0·317	856·8	341·4	0·264	713·5	284·3	...	...	...	125
"	"	"	0·510	879·3	353·4	0·572	986·2	396·5	4·29	0·79	...	126

STATEMENT

Results of Analysi

Serial Number.	Name.	Alcoholic Strength.		Acidity.			Aldehydes.		
		Under proof.*	True strength in volume per cent.	Grams per litre.	Mgms. per 100 c. c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Mgms. per 100 c. c. of absolute alcohol.	Grains per proof gallon.
1	2	3	4	5	6	7	8	9	10
						VI.—DIFFEREN			
127	Palm Toddy	95·7	2·4	2·430	10,125·0	3,955·8	V. s. t.	V. s. t.	V. s. t.
128	Sago "	92·1	4·5	1·200	2,666·6	1,063·3	"	"	"
129	Sago "	88·9	6·3	1·110	1,761·9	700·0	*Nil.*	"	"
130	Date "	91·7	4·7	1·860	3,957·5	1,568·7	V. s. t.	"	"
131	Date "	93·9	3·5	1·620	4,628·6	1,859·0	"	"	"
132	Palmyra Toddy	92·0	4·6	1·230	2,673·9	1,076·2	"	"	"

NOTE—V. s. t. = Very slight trace.

* Given in proof terms for the convenience of those accustomed only to use such.

B—*concld.*

of Fermented Liquors.

Furfural.			Fusel oil as amyl alcohol.			Ethers.			Percentages, (strictly grams per 100 c c.)			
Grams per litre.	Mgms. per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Mgms. per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Mgms. per 100 c c. of absolute alcohol.	Grains per proof gallon.	Sugars per cent.	Albuminoids per cent.	Total solids per cent.	Serial Number.
11	12	13	14	15	16	17	18	19	20	21	22	
TODDIES—(*contd*).												
Nil	*Nil*	*Nil*	0·942	3,925·0	1,533·5	0·352	1,466·6	573·0	7·36	0·08	...	127
"	"	"	0·185	411·1	163·9	0·176	391·1	155·9	2·97	0·34	...	128
"	"	"	0·255	404·7	160·8	0·440	698·4	277·4	...	1·02	...	129
"	"	"	0·308	655·3	259·7	0·264	561·7	222·6	...	0·44	...	130
"	"	"	0·326	931·4	374·1	*Nil.*	...	...	...	0·44	...	131
"	"	"	0·343	745·7	300·1	0·066	143·5	57·7	...	0·44	...	132

APPENDIX TO SECTION B.

STATEMENT C.

RESULTS OF ANALYSIS

OF

PORTS AND OTHER WINES, &c.

I.—Ports;

II.—Miscellaneous Wines;

III.—Cordials.

STATEME

Results of the Analy

Serial Number.	Name.	Alcoholic strength in Volume per cent.	Acidity.			Aldehydes.		
			Grams per litre.	Milligrams per 100 c. c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c. c. of absolute alcohol.	Grains per proof
1	2	3	4	5	6	7	8	9
	I.—Ports.							
1	Fine old port, Germany	18·1	0·900 F. 0·176	497·2 97·2	198·1 38·8	0·057	31·5	1
2	Fine old Port wine, Spain	19·6	0·540 F. 0·234	275·5 119·4	110·2 47·7	0·025	12·7	
3	Superior Spanish Port wine	16·3	1·110 F. 0·283	680·9 173·6	271·3 69·3	0·034	20·8	
4	Very superior choice Port (Spain)	18·5	0·450 F. 0·189	243·2 102·0	97·2 40·8	0·020	10·8	
5	Port wine of Invalids (Spain)	22·4	0·480 F. 0·203	214·3 90·6	85·9 36·3	Tr.	Tr.	T
6	Superior Spanish Port	18·9	0·510 F. 0·203	269·8 107·4	108·0 43·0	Tr.	Tr.	T
7	Spanish Port	19·0	0·600	315·8	126·1	0·012	6·3	
8	Genuine Port wine (bottled at Bombay)	17·5	0·660	377·1	150·9	0·022	12·5	
9	Superior old Port wine (bottled at Bombay)	20·7	0·750	362·3	144·6	0·011	5·3	
10	Portwine (bottled at Bombay)	21·0	0·720	342·9	136·6	0·013	6·2	
11	Invalid Port (Portugal)	18·9	0·930	492·0	196·7	0·015	7·9	
12	Fine old Invalid Port (bottled at Calcutta)	19·5	0·390	200·0	80·0	0·014	7·1	
13	Imperial Port (Portugal)	20·6	0·540 F. 0·319	262·1 154·8	104·7 61·9	V. s. t.	V. s. t.	V.
14	Invalid Port	19·7	0·570 F. 0·317	289·3 160·9	115·6 64·3	0·072	36·6	1
	II.—Miscellaneous Wines.							
15	Pale Dry Sherry (Spain)	19·4	0·930	479·3	195·5	0·014	7·2	
16	Champagne	14·0	4·110	2935·7	1169·5	*Nil*	*Nil*	*N*
17	Rich old Madeira	21·2	0·750 F. 0·393	353·8 185·4	141·5 74·1	0·072	33·9	1
18	St. Estéphe Claret	10·4	0·900 F. 0·472	865·4 453·8	346·1 181·5	0·130	125·0	5
19	Chablis No. I	11·8	0·810 F. 0·020	686·4 16·9	275·2 6·8	V. s. t.	V. s. t.	V.
20	Beaune	10·5	0·600 F. 0·020	571·4 19·0	229·5 7·6	*Nil*	*Nil*	*N*
21	Haut Sauternes	11·7	1·050 F. 0·025	897·5 21·4	358·5 8·5	*Nil*	*Nil*	*N*
22	Hochheimer, 1895	10·8	0·390 F. 0·020	361·1 18·5	143·7 7·4	*Nil*	*Nil*	*N*
	III.—Cordials.							
23	Rose cordial (bottled at Calcutta)	9·9	0·030	30·3	12·1	0·009	9·0	
24	Crême de Rose (bottled at Calcutta)	15·7	0·015	9·6	3·8	Tr.	Tr.	T
25	Ditto ditto	14·9	*Nil*	*Nil*	*Nil*	0·018	12·1	
26	Ditto ditto	17·9	0·015	8·3	3·3	Tr.	Tr.	T

Note—F=Fixed.

V. s. t.=Very slight trace.

Tr.=Trace.

—III.

f wines, etc.

Furfural.			Fusel oil as Amyl Alcohol.			Ethers.			Percentages of				
Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Sugar.	Tannin.	Total solids.	Ash.	Serial number.
10	11	12	13	14	15	16	17	18	19	20	21	22	
0·030	1·6	0·7	0·220	121·5	48·4	0·352	194·5	77·4	13·18	*Nil*	13·40	0·18	1
0·003	1·5	0·6	0·317	161·7	64·7	0·308	157·1	62·9	7·77	0·04	16·09	0·31	2
0·001	0·6	0·2	0·185	113·5	45·3	0·440	269·9	107·6	8·28	0·05	10·74	0·26	3
0·002	1·1	0·4	0·247	133·5	53·3	0·176	95·1	38·0	5·30	0·14	6·06	0·28	4
Nil	*Nil*	*Nil*	0·202	90·2	36·1	0·352	157·1	63·0	5·12	0·10	6·81	0·36	5
Tr.	Tr.	Tr.	0·299	158·2	63·2	0·308	163·0	65·1	5·43	0·20	6·75	0·30	6
0·001	0·5	0·2	0·290	152·6	60·9	0·150	78·9	31·5	4·72	0·39	12·11	0·23	7
Tr.	Tr.	Tr.	0·211	120·5	48·2	0·150	85·7	34·3	5·07	0·75	11·37	0·21	8
Tr.	Tr.	Tr.	0·308	148·8	59·4	0·210	101·4	40·5	7·05	0·49	9·82	0·31	9
0·001	0·5	0·2	0·484	230·5	91·9	0·176	83·8	33·4	5·17	0·05	13·84	0·30	10
Tr.	Tr.	Tr.	0·466	246·5	98·6	0·360	190·4	76·1	6·05	0·06	0·28	0·28	11
0·002	1·0	0·4	0·466	238·9	95·7	0·510	261·5	104·7	12·83	0·15	14·11	Not determined.	12
. s. t.	V. s. t.	V. s. t.	0·519	251·9	100·6	0·520	252·4	100·9	7·21	0·08	8·36	0·25	13
Nil	*Nil*	*Nil*	0·783	397·4	158·8	0·396	201·0	80·4	7·49	0·05	8·95	0·27	14
Nil	*Nil*	*Nil*	0·405	208·7	83·4	0·704	362·9	144·9	0·83	0·04	0·87	0·17	15
Nil	*Nil*	*Nil*	0·678	484·3	192·9	1·496	1068·6	425·7	1·18	*Nil*	2·24	0·13	16
Nil	*Nil*	*Nil*	0·862	406·6	162·6	0·880	415·1	166·0	7·09	0·08	9·73	0·41	17
Nil	*Nil*	*Nil*	0·528	507·7	203·0	0·440	423·0	169·2	0·53	0·13	2·09	0·28	18
. s. t.	V. s. t.	V. s. t.	0·440	372·9	149·5	0·440	372·9	149·5	1·11	0·07	1·66	0·22	19
Nil	*Nil*	*Nil*	0·334	318·1	127·7	0·264	251·4	100·9	*Nil*	0·23	1·43	0·24	20
Nil	*Nil*	*Nil*	0·854	729·9	291·6	0·440	376·0	150·2	1·04	*Nil*	2·65	0·27	21
. s. t.	V. s. t.	V. s. t.	0·361	334·2	133·0	0·440	407·4	162·1	*Nil*	*Nil*	1·94	0·28	22
Tr.	Tr.	Tr.	0·766	773·7	308·1	*Nil*	*Nil*	*Nil*	32·71	*Nil*	37·94	Not determined.	23
Tr.	Tr.	Tr.	0·528	336·3	134·4	0·044	28·0	11·2	29·40	„	30·77		24
Tr.	Tr.	Tr.	0·247	165·8	65·9	0·044	29·5	11·8	32·07	„	36·20		25
Tr.	Tr.	Tr.	0·546	305·0	121·7	0·066	36·8	14·7	52·74	„	63·36		26

APPENDIX TO SECTION B.

STATEMENT D.

RESULTS OF ANALYSIS

OF

COUNTRY WINES AND FOREIGN CORDIALS.

STATE

Results of Analysis of Country

Serial number.	Name.	ALCOHOLIC STRENGTH *in Vol. per cent.*			ACIDITY.			ALDEHYDES.		
		Apparent.	True.	Percentage obscuration.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.
1	2	3	4	5	6	7	8	9	10	11
1	Kümmel (Russian) ...	...	43·4	...	0·090	20·7	8·3	*Nil.*	*Nil.*	*Nil.*
2	Vermouth (French) ...	...	19·9	...	4·860	2442·2	977·6	*Nil.*	*Nil.*	*Nil.*
3	Maharaja Liqueur... ...	48·5	51·8	6·4	0·480	92·6	37·0	V. s. t.	V. s. t.	V. s. t.
4	Maqawwavi Dimagh ...	47·3	48·0	1·4	0·510	106·2	42·5	V. s. t.	V. s. t.	V. s. t.
5	The Wine of Sandal ...	46·3	46·8	1·1	0·480	102·5	40·9	0·125	26·6	10·6
6	Superior Musk Wine ...	43·6	47·6	8·4	0·660	138·7	55·4	V. s. t.	V. s. t.	V. s. t.
7	Rose Wine	47·1	48·4	2·7	0·930	192·1	76·8	0·068	14·0	5·6
8	Fine Seb Liqueur... ...	46·3	49·6	6·6	1·200	241·9	96·7	0·100	20·1	0·8
9	Superior Orange Wine ...	47·5	47·6	0·2	0·810	170·1	67·9	0·054	11·3	4·5
10	„ Caprot Wine ...	47·3	48·4	2·3	0·660	136·3	54·5	0·066	13·6	5·4

NOTE.—V. s. t.=

MENT D.

Wines and Foreign Cordials.

Furfural.			Fusel Oil as Amyl Alcohol.			Ethers.			Percentage.	
Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Grams per litre.	Milligrams per 100 c.c. of absolute alcohol.	Grains per proof gallon.	Sugar.	Serial number.
12	13	14	15	16	17	18	19	20	21	
Nil.	*Nil.*	*Nil.*	1·778	409·6	163·7	0·132	30·4	12·1	195·443	1
Nil.	*Nil.*	*Nil.*	0·818	411·0	164·5	0·264	132·6	53·1	53·255	2
0·011	2·1	0·8	1·567	302·5	121·0	1·320	254·8	101·9	*Nil.*	3
0·006	1·2	0·5	1·505	313·6	125·4	0·396	82·5	33·0	*Nil.*	4
0·016	3·4	1·4	1·179	251·9	100·6	0·440	94·0	37·5	*Nil.*	5
0·009	1·9	0·8	1·206	253·4	101·2	1·320	277·3	110·8	*Nil.*	6
0·011	2·3	0·9	0·607	125·4	50·1	0·748	154·6	61·7	*Nil.*	7
0·011	2·2	0·9	0·810	163·3	65·3	1·320	266·1	106·4	*Nil.*	8
0·020	4·2	1·7	1·558	327·3	130·7	1·276	268·0	107·1	*Nil.*	9
·012	2·5	1·0	1·593	329·1	131·5	1·056	218·1	87·1	*Nil.*	10

slight trace.

C.

"PHYSIOLOGICAL" SECTION.

THE ACTION OF THE BY-PRODUCTS OF ALCOHOL AND OF PURE ALCOHOL.

Chapter IV.—Results of local enquiries as to prevailing drinking habits and effects of liquors used throughout India.

Chapter V.—"Physiological Action" of the by-products of alcoholic liquors and of alcohol itself; with Summary of previous work on the subject.

Chapter VI.—Results obtained as to the action of by-products and of alcohol during the present enquiry.

CHAPTER IV.

RESULTS OF LOCAL ENQUIRIES AS TO PREVAILING DRINKING HABITS AND EFFECTS OF LIQUORS USED THROUGHOUT INDIA.

The list of questions drawn up by me at the request of the Excise Committee and circulated by them throughout India to officers in charge of districts, medical officers, excise officers, missionaries, &c., is given in the appendix to the present section (p. 148).

These questions were intended to elicit information as to—

(*a*) prevalent drinking habits ;

(*b*) drugging of liquors ;

(*c*) any kind of liquor found to produce particularly noxious results ;

(*d*) special preferences existing among natives for any type of liquors.

In the following chapter are briefly summarised the answers received.

The replies to the first two questions regarding the relative amounts of the different varieties of alcoholic liquors used in the various districts throughout India and the extent to which in each district these are obtained from distilleries or out-stills are inconclusive and the summary of them has consequently been omitted.

PRACTICES OBTAINING AS REGARDS ALCOHOLIC CONSUMPTION.

Average daily consumption of spirits and fermented liquors.

The Average Daily Consumption by a moderate drinker appears from the replies received to be, for spirits, between ¼ and ½ a bottle (say 6 to 12 ounces).

For fermented liquors the average is well under two bottles (say 50 ounces).

Time of day when chiefly consumed.

Spirits are generally drunk in the evening (135 replies state the evening and 6 "throughout the day"). Toddy and rice beers are usually drunk at intervals throughout the day or more rarely only in the morning or afternoon. There is, as might be expected, an increase of drinking at private and religious festivals, fairs, &c., but most replies go to show that this, speaking generally, is not serious.

Dilution customs of consumers.

116 replies show that *country spirits are usually taken undiluted* but that *imported liquors are generally diluted* (especially in hot weather). 26 replies state the reverse ; and the practice of diluting 25 U. P. liquor with 60 U. P. liquor is mentioned.

SPECIAL RESULTS OF ALCOHOLIC INDULGENCE.

No particular liquor in moderation interferes with power to resume work next day.

127 replies (as against 13 others) show that no *particular* liquor interferes with the power to resume work next day unless, of course, used in marked excess or in the case of drugged liquor. Moderate drinking is very frequently stated to be the general rule and drunkenness to be comparatively rare.

In Cachar, Assam, it was stated in one reply that 20 per cent. of the coolies are unable to work after a drinking bout and that 9 per cent. are similarly affected after each weekly pay-day. This is, of course, only what one would expect after drinking to excess as has been alleged to be the rule on many tea-estates in Assam, *i.e.*, there is nothing to indicate that it is not merely a question of the quantity, rather than of the quality, of the alcoholic beverage consumed.

Two opinions are expressed to the effect that *mahua* spirit interferes most of all with the power to resume work and another alleges the same regarding molasses spirit ; while another mentions cheap German spirit as having a like effect. It would certainly appear, from many of the replies received, to be a question more of quantity consumed than of quality or type of spirit.

No particular liquor speedily produces helpless intoxication when taken in small amounts.

No special liquor consumed in India appears to have the power of speedily producing helpless intoxication in relatively small amounts.

When this result occurs it appears to be due to high alcoholic strength or in comparatively rare instances, to drugging. Thus spirits made from a basis of sugar-refuse (*because usually stronger in alcohol than mahua*) are stated to produce intoxication more quickly than mahua spirits. And the combination of sugar-residues with mahua is well known to be employed in order to obtain a stronger spirit than from mahua alone. Cheap rum is in one case stated to cause intoxication more rapidly than *mahua* spirit : here again probably only from higher alcoholic strength.

Rate of recovery from effects.

Cases of particularly slow recovery from any variety of alcoholic drink are in 25 cases stated to be unknown but 14 replies specify the following :—

(*a*) Recovery is slower after drinking imported spirits than after country spirits.

(*b*) Recovery is twice as slow from *mahua* as from toddy spirits.

(*c*) Recovery from rum is slower than from *mahua*.

(*d*) Recovery is quicker from "*phul*" and "*Toone*" than from "*Bungla*."*

(*e*) Recovery from Kotri Distillery liquor is stated to be very slow.

(*f*) Recovery is (naturally) very slow after drugging spirit with *dhatura*.

Habitual indulgence in, and individual susceptibility to, alcohol are also to be considered in this connection. Nearly all the above exceptions are explainable by differences in alcoholic strength in the liquors compared.

Particularly noticeable after-effects (loss of appetite, altered temper, long continued drowsiness or trembling) were stated not to occur in 63 replies as against 11.

More marked after effects with any particular liquor.

As regards the latter, these symptoms were stated to be more marked after partaking of country spirit than after toddy, which is scarcely remarkable. In three cases, imported spirits were stated to produce these effects more than country spirits ; and "fermented out-still liquors" were blamed in two cases. The Punjab Excise Commissioner stated that patent-still spirits from Amritsar Distillery were reputed to produce worse headaches than pot-still spirits.

Here again the only comment is that no specially deleterious liquor has been indicated and that tne contrasts noted must chiefly be ascribed to differences in alcoholic strength.

Relation between purposeless crime and the consumption of any particular kind of liquor.

No connection was observed between the use of any particular liquor and the production of purposeless crimes of violence (69 replies as against 9).

In one case it is alleged that *mahua* produces a fiercer and more irritable type of drunkenness. This, however, is not confirmed by others and is probably an observation made on some special case in which alcohol produced these effects in a particularly susceptible individual.*

Old "tari" considered specially injurious.

Of the Indian liquors credited with special action in this way, *old tari* is stated to cause mild maniacal states. In one case spirit made from the Cashew fruit (*Anacardium occidentale*) is alleged to cause even in small amounts "great excitement, assaults and purposeless crime." "Shamshoo" (rice spirit) is, in one case, stated to have a like effect; as are imported spirits in comparison with country spirits. Kotri Distillery spirits are in two instances also alleged to have this effect.

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* With aborigines the effects of spirits are apt to be much accentuated. Dr. Reid ("Alcoholism," page 107) states that "savages are proverbially intemperate. They are furious drinkers and are furious in their drink. Their intemperance frequently takes a more violent and homicidal form than is common amongst Europeans."

Old tari is frequently credited with having a very deleterious action and this probably is chiefly on account of its usually very high acidity and the products of its decomposition, rather than from any increase in actual intoxicating effects.

As to the allegation regarding Cashew spirit I can give no opinion as I have had no chance of examining any such spirits. (The information was only received at the end of my period of deputation regarding Cashew and *Juar*, *i.e.*, millet spirits.)

"Shamsho" and Kotri Distillery spirits are said to act relatively more potently (chiefly, if not entirely, on account of higher alcoholic strength) than the out-still and fermented liquors which chiefly compete with them. If a person who is accustomed to drink only weak fermented liquors partakes of strong spirits freely the result is likely to be as stated above.

No special mental effects produced by any particular liquor.

38 answers (as against 8) state that no maniacal or other exceptional mental states follow the use of any particular alcoholic drink. Old tari has already been noted in this connection. In one case mahua spirit to which *juar** root has been added is stated to be more potent. I have had no opportunity of examining the action of *juar* root in this connection. *Mahua* spirit when freshly made is also said to be more intoxicating than the old spirit. New *mahua* spirit would tend to be alcoholically stronger than old (and also to contain more by-products which to some very slight extent might possibly tend to enhance its action). The rapid improvement following maturation of *mahua* spirit is borne out by the facts recorded in the Chapter on Maturation but no marked relative superiority of *mahua* spirit in this respect over other types of liquor has been so far ascertained.

The few remaining cases mentioned appear to be exceptional and to be explicable simply by the effect of strong spirits on more or less specially excitable and susceptible subjects.

No unusual conditions produced by any liquor particularly.

No *unusual* conditions referable to the use of any particular alcoholic liquor appear to be known (44 replies as against 1). The single exception was stated to be in the case of *mahua* which tended to cause "shaking palsy." But such symptoms would be equally produced by over-indulgence in any other kind of spirit.

Sexual perversions were stated (by a medical officer) to occur when hemp, nux vomica and *dhatura* were used to drug liquor. This statement requires confirmation.

Alcoholic neuritis in India.

No disease specially referable to the use of any particular Indian liquor.

Alcoholic Neuritis.—In 23 cases as against 7 experience of this disease was denied by the medical officers consulted. In the case of the seven affirmative replies the cases were stated to be specially mild or were reported on indirect information. The impression seems to prevail among the medical men consulted that this disease is not nearly so common as in England and in fact is hardly at all known in India among natives.

No symptoms specially referable to any bodily "system" (nervous, renal, &c.) was traceable to the use of any *particular* variety of alcoholic liquor as indicated by 27 as against 7 replies.

In 5 cases, liver abscess was stated to be commoner after habitual indulgence in country liquors than in the case of imported spirits. *Mahua* spirit in one case was stated to cause specially severe headaches.

The "grog" used by Assam coolies was credited with particularly tending to cause inflammation of the stomach and, as a result, malnutrition.

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* Spirits made from cashew or *juar* are very rarely encountered.

The allegations as regards the effects of *mahua* spirit and grog are, of course, equally applicable to the case of other spirits, but are not unlikely to be connected with the use of very acid liquor, as these generally prove to be. 41 replies (as against 5) show that no definite diseases referable to the consumption of Indian-made liquors occur which are different from those produced by imported liquors.

Of the five exceptions noted it is stated that—

(*a*) There is less liability to liver affections in the case of country spirit as compared with imported spirit (higher alcoholic strength of the latter would tend to explain this).

(*b*) The apparent opposite of (*a*) is stated, *viz.*, that there is a greater liability to liver complaints and digestive disturbances from the consumption of country spirit than from that of imported spirits. Two medical officers state this and in one case the very acid nature of the liquor and the *supposed* high fusel content are blamed for this effect. The highly acid liquor would certainly tend to produce digestive complaints.

(*c*) "All the diseases which English liquor produces slowly, country liquor produces rapidly". Very sour country liquor would tend to somewhat more rapidly cause digestive disturbances than the very slightly acid imported liquor of like alcoholic strength; otherwise, this statement is unconfirmed.

(*a*) and (*b*) appear to be contradictory statements but are not so. Liver disease would certainly tend to be produced more by habitually drinking strong rather than weak spirits. On the other hand, in general, the very sour country liquor would tend to cause digestive disorders (and incidentally liver disorders) than a much less sour liquor of equal strength. The same remark applies to (*c*).

Drugging of liquors.

Drugging of spirits with such poisons as nux vomica, dhatura, tobacco, aconite, hemp, &c.—The existence of this practice is denied in 33 (out of 68 replies) but 35 answers state that drugging of liquor is prevalent.

Red pepper to give "bite" and "fortify"; Chiretta with the idea of increasing rapidity of intoxication; "Kukra" (see special note on this substance); *Trigonella Foenum*; worm-wood; *Cocculus Indicus*; Walnut and *Kikar* juices (in addition to the poisons mentioned in the heading of this paragraph) are all stated to be more or less in use in various parts of India. (This subject is dealt with in a special chapter of this Report). In scarcely any case has confirmation of these allegations by analyses (made by Chemical Examiners to Government or otherwise) been noted.

Native ideas as to different classes of liquors.

Native ideas as to the relative harmfulness or harmlessness of particular kinds of alcoholic drink.—The opinion is almost universally expressed that fresh *tari* is the least harmful of all alcoholic beverages. It is considered nutritious and "tonic". (See page 3~~0~~ for confirmation of this.)

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Imported spirits are somewhat frequently stated to have worse effects than country spirits (probably because of their usually somewhat higher alcoholic strength). It is alleged that spirits generally and particularly imported spirits are believed to be better suited for meat-eaters than for vegetarians, and that indulgence in them necessitates a meat diet. This is true to some extent for it is a well-recognised fact that vegetarians have much less inclination to alcoholic indulgence as a rule than have meat eaters. Spirit drinking and meat-eating certainly tend to go together to some extent in India as well as in other countries.

Cheap imported liquors are credited with worse effects than country made spirits; and they are also stated to be "less satisfying", and to cause a "worse headache" afterwards. Rice spirit has been several times alleged to be more wholesome than molasses spirit.

But in practice it is doubtful if considerations of relative harmfulness of liquor are ever seriously considered. Cost is the chief factor with the poor man;

and a perverted notion as to " respectability " appears to be largely operative with the class who drink " imitation " spirits (imported or Indo-European). Other reasons for preference are that such liquors can generally be obtained more secretly and can be stocked in the house in relatively larger amount ; and that the strong smell of *mahua* spirit is not only disliked by many but betrays the fact of indulgence in it to others very readily.

The force of European example in the selection of liquors for consumption is also to be reckoned with ; and among certain classes of natives and Eurasians, European liquor, imitation or real, undoubtedly is considered more " fashionable " and is bought in preference to country liquor, particularly if the cost of the two approximate closely.

Broadly speaking, then, country liquors are preferred mainly on the score of cost by the poorest classes ; and cheap imported and Indo-European spirits by the classes somewhat more well to do, *i.e.*, well enough off to be able to afford to buy them ; while the richer classes appear to prefer imported liquors or spiced Indian-manufactured liquor.

As regards any preference for the different varieties of country spirits, in some districts *mahua* spirit is preferred to molasses or *gur* spirit (probably chiefly from custom) and in others the opposite is the case. The odour and taste of *mahua* spirit are in certain cases stated to be more unpleasant than are those of spirits made from sugary bases or from toddy. As before mentioned, the product of the pot-still is preferred to that of the patent-still in some parts of the Punjab, the latter spirit being stated to cause severe headache.

Alcoholic liquors as prophylactics of certain diseases.

The idea seems very prevalent that alcoholic liquors tend to prevent cholera and plague and, in the Terai, it is also stated, malaria. This is a specially pernicious popular delusion for over-indulgence in alcohol markedly tends to lower the individual's resistance to all these, in common with other acute and specific, diseases.

Period of increased alcoholic indulgence.

Increased drinking in general appears to occur. during the cold season (especially in Northern India) and to a less extent in the rains and hot weather ; during the *tari* season ; at harvests ; on pay days ; during epidemics ; marriages ; and at such festivals as Holi, Diwali, &c.

Fermented *versus* distilled liquors.

Relative effects of fermented and distilled liquors.—It is well known that habitual consumers of fermented liquors do not drink spirits as a rule and *vice versâ.* In the first case cost, usage and restricted opportunity would appear to be the chief causes ; and of course, in the converse case, the spirit-drinker finds fermented liquors too weak for his taste. With very few exceptions, the opinion obtains that spirits produce much more serious effects than do fermented liquors. The experience of other countries tends to support this view.

Old tari is, however, occasionally credited with producing maniacal symptoms, long continued headache, rheumatism, vomiting and choleraic diarrhœa. The effect of so strongly acid and putrefying a liquor would certainly tend to cause the digestive and rheumatic symptoms noted, but the cause of the alleged maniacal symptoms is not clear.

CHAPTER V.

"PHYSIOLOGICAL ACTION" OF THE BY-PRODUCTS OF ALCOHOLIC LIQUORS AND OF ALCOHOL.

Alcohol (*ethylic*).—When taken in sufficiently large doses it kills either by paralysis of the heart or of the nervous centres controlling respiration. In fatal doses, it either kills immediately by shock or usually within 24 hours.

Circumstances modifying the action of alcohol.

The action of alcohol varies according to—

(*a*) the dose taken ;

(*b*) the degree of alcoholic concentration ;

(*c*) the age of the person ;

(*d*) individual susceptibility ;

(*e*) whether tolerance has or has not been established by its more or less frequent use ; and

(*f*) by the character of the spirit (*e.g.*, in the special case of absinthe where the specific action is due to the presence of a volatile oil obtained from the wormwood used in flavouring that liquor).

Fatal doses recorded in the case of human beings.

The fatal dose varies according to the age and constitution of the person, *e.g.*, a boy of three died after drinking 75 grams of gin ; another boy of seven after 100-120 grams of brandy ; another boy of twelve after 100 cubic centimetres of brandy ; and an adult man (age not stated) after 330 grams of alcohol contained in two bottles of port consumed in two hours (1)*.

And of dogs.

In the case of dogs, *5 to 6 grams of alcohol for each kilogram of body-weight* appears to be the *fatal* dose (Dujardin-Beaumetz, Audije, Lussanna, Albertoni).

General summary of the action of alcohol.

The predominating importance of Ethyl Alcohol in the composition of alcoholic beverages renders it desirable, if only for purposes of reference, to here briefly outline its action on the various "systems" of the body.

Applied to the skin and allowed to evaporate, it abstracts heat and causes a sensation of coolness. If not allowed to evaporate, it causes redness and even inflammation (2).*

In the stomach a like action to the latter results so that the desirability of sufficient dilution (by water or food) becomes evident.

In the stomach.

Concentrated alcohol increases the muscular activity of the stomach, produces a large secretion of mucus, but diminishes the secretion of digestive juices (gastric and pancreatic). When well diluted or in small amounts, these actions do not occur. Its retarding influence on digestion when concentrated and in large amount is very marked but it is so rapidly absorbed from the stomach that moderate quantities probably do not continue long to act in this way for it is found that when the alcohol becomes lessened in amount the digestive retardation-action ceases. The "dilution" of alcohol in the stomach is relatively increased by the fact that water is not absorbed by the stomach, while alcohol very rapidly is. A stronger solution of alcohol is absorbed much more rapidly than a weaker one.

Alcohol aids the digestion of fats by its solvent action. It also helps the absorption of certain other substances. The continued action of alcohol in large amounts is well known to give rise to catarrhal conditions of the stomach which render the appetite bad and interfere very seriously with digestion.

Excretion of alcohol.

In the system, nearly all the alcohol absorbed appears to be used up contrary to the former belief that large quantities escape in the breath, sweat, etc. The so-called "alcoholic" smell of the breath is now considered to be largely occasioned by the ethereal compounds present in the spirit or produced in the system by combinations with the alcohol ; and Binz, Strassmann and others (3)* have shown that only about 3 to 5 per cent. of the alcohol taken can be recovered from the breath, sweat, etc. Many authorities but not all consider that Alcohol acts in some measure as a food (though certainly by no means a necessary one in health) but its use is fraught with so many collateral disadvantages that it can only be in certain selected cases of disease that its action as such should be employed.

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* These numbers refer to the References at the end of this Chapter.

Action as food.

Its "fattening" action is accompanied by verv grave disadvantages such as the replacement by fat of muscular tissue in the heart and of glandular tissue in the liver, kidney, etc., thus leading to fatty degenerations of the heart, kidneys, liver, etc.

In health it lowers the bodily temperature only (according to certain observers) when given in large quantities. The experiments conducted by Parkes showed that when given *on an empty stomach* a "dietetic dose" of two ounces of (absolute) alcohol slightly lowered the body temperature.

Action on Body's temperature.

On the nervous system, it first acts on the higher functions and the action is a more or less brief initial stimulation followed by a depressant effect which is in reality a more or less mild condition of temporary paralysis of nervous function.

On nervous system.

It is this "sedative" action of alcohol and the sense of contentment associated with it that forms its chief attraction to the average consumer. It is thus strictly speaking incorrect to describe the action of alcohol as stimulant: at first it certainly is so for a brief period but *the bulk of its action* is just the opposite to stimulant.

An important point to be here noted is the curious selective action of alcohol for different parts of the nervous system in different individuals and the varying degree to which even the same dose of the same liquor will affect various people. This latter action is, of course, a matter of every day experience but its real significance appears to be too much over-looked in trying to form an estimate of the *comparative* effects of alcoholic liquors. It has been suggested (on what appear to be insufficient grounds) that certain by-products of alcohol are associated with the production of crime. My own observations as to this (from a medico-legal point of view as well as from that of the present enquiry) incline me to the belief that we must look for the explanation as to why alcohol taken in excess may produce criminal outbursts of violence, etc., in one man and not in another (both of whom have taken about the same amount of the same liquor) chiefly to individual susceptibility to the action of alcohol rather than to the character of its by-products.

Selective action on various portions of nervous system.

In various individuals we encounter all shades of susceptibility to the action of alcohol side by side with a wide variation in the degree of control (inhibition)—moral and mental. Alcohol has the general effect of *lessening inhibition* and it is because of this mainly that we note the modifications produced by it of a man's customary demeanour and habits, *e.g.*, the silent man may become loquacious, and the quiet man pugnacious; while, conversely, the morose may often become more morose instead of less. The "paralysing effect" is further shown by the thick blurred speech, stumbling gait, etc.

Degrees of susceptibility to its action.

In, say, the case of two men drinking approximately the same amounts of the same alcoholic drink the power of control in the one case will remain within fairly normal limits while in the other some idea or some outside stimulus may cause an ungovernable outbreak of violence leading to assault, murder or other crime. The difference appears, then, to be due to the greater relative weakening of control and the loss or impairment of judgment by the poisonous action of the alcohol in the one case, or even to the production of temporary delusional conditions leading to violent outbursts. I shall return to this subject later but it has seemed as well to refer to it here in dealing with the action of (ethylic) alcohol on the nervous system.

Influence in production of crime.

Slowing of "reaction-time" by small doses of alcohol.

The effect of alcohol on the higher nervous centres even in small "dietetic" quantities taken along with meals and usually considered harmless may be gauged by contrasting the rapidity and accuracy with which mental work, (*e.g.*, arithmetical calculations) can be carried out after such small doses and during periods of alcoholic abstention.

This slowing of action can be clearly and accurately indicated by certain instrumental methods of recording the so-called "reaction time." *

Kraepelin (*3 a*) has shown that after a small dose of alcohol there is first a brief acceleration of the "reaction time" followed in a few minutes by marked slowing. Complex reactions are slowed throughout. One of the most important actions of alcohol is the disturbance of the controlling mechanism of the brain—one of its highest functions.

Aschaffenberg has shown that in the case of skilled volitional work, as in setting-up type, small doses of alcohol cause a very pronounced slowing of function.

In short, alcohol appears to be a "protoplasmic poison" and one of its most obvious actions as such is its more or less pronounced paralysing action on the functional activity of the brain-cells. This may perhaps be regarded as the central fact of the action of alcohol.

† "Alcoholism" (1902) page 66.

Effect of strictly moderate drinking on longevity.

Dr. Archdall Reid† states that "all except fanatical abstainers are agreed that strictly moderate drinking influences the death-rate little if at all. Thus few would maintain that the lives of the temperate Spanish or Italian peasants are shortened by their habitual use of alcohol." While, then, most people who have considered the evidence closely are assured that alcohol is primarily an article of luxury which in the vast majority of cases people would be better without yet it seems equally clear that man all the world over is prepared to accept the disadvantages of alcoholic indulgence in return for the undoubted pleasure or relief he derives from it.

Reid points out (op. cit., pages 72-3) that man uses alcohol for one or more of three purposes, *viz.*

(*a*) to alleviate thirst and this type is represented by the beer-drinker;

(*b*) as a pleasant flavoured drink, as in the case of the wine-drinker; or

(*c*) for its effects on his nervous system, and for this purpose spirits are generally preferred.

This last is also in most countries the dangerous class of consumer for it includes most drunkards. But here again Indian conditions and habits have to be considered and the evidence available appears to point to the fact that moderate drinking is the rule.

Another conclusion arrived at by Dr. Reid, who has made a special study of alcoholism in relation to heredity, may be here mentioned:

"All men, of course, start life without any craving for alcohol and, in so far are equal but the essential fact remains that they differ vastly with respect to the ease with which the craving may be awakened and the strength it may attain." He considers that people are temperate not in spite of their inclinations but because of them.§ Most people are temperate because indulgence in alcohol beyond a certain point does not attract them (*i.e.*, does not awaken any craving).

* * * * * * *

Action on Respiratory system.

Respiration is generally markedly increased in rate; and in toxic doses the breathing becomes much interfered with from depression of the nervous centres controlling respiration.

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* "Reaction time" is the time which elapses between the receipt of a stimulus (mental is this case) and the carrying out of the proper response to it. For example, a person is told to alter the hand of a watch from one time to another specified time. The time taken from the receipt of the order to the completion of the act specified is the "reaction time."

§ Op. cit., pages 81-2.

And on the circulatory system.

The surface blood-vessels generally become dilated giving a fictitious sense of body warmth but the deeper vessels appear to become constricted under the action of alcohol.

Dr. W. E. Dixon, of Cambridge, (4) has recently found that small quantities of concentrated alcohol at first quicken the pulse and the force of the heart's action but have no such effect if much diluted; while, in very large doses, the pulse is slowed. If much diluted, alcohol has little effect on the heart's action but, in too large doses, depresses it.

Alcohol in excess lowers resistance to certain diseases.

Alcohol in excess markedly lessens the body's power to resist acute and specific diseases; and is believed to interfere with the acquisition of immunity.

The above account is not intended to be in any way exhaustive and certain well known actions have been purposely omitted.

ACTION OF THE BY-PRODUCTS.

Furst on fusel oil's action.

"Fusel oil" was found by Furst (5) to have first a stimulating and then a depressing action, passing into stupefaction and later passing off (our experiments amply confirm this).

Two to four drachms of "fusel oil" quickly killed dogs and rabbits, causing "gangrene" of the stomach. These enormous doses we have not administered as being beside our purpose. It would appear that in Furst's experiments the "fusel oil" (? Amyl alcohol chiefly) was given undiluted or insufficiently diluted and owing to the relative insolubility of the higher alcohols the local irritant action was prolonged sufficiently to cause "gangrene" of the stomach.

Richardson's observations on relative toxicity of higher alcohols.

Sir B. W. Richardson in 1865 found that the relative toxicity *as determined by the lethal doses* of the higher alcohols found in spirits depends on their molecular weight. As this increased, so did the action heighten.

The exactness of this work was doubted by Dujardin-Beaumetz and others but Baer and Bradbury (6) have independently confirmed its accuracy and my results go to further confirm Richardson's.

Taking *Ethyl* alcohol as represented by unity, the relative toxicities of these substances were found by Baer to be:—

Methyl or wood alcohol (CH_3OH)	0·8
Ethyl alcohol (C_2H_5OH)	1·0
Propyl „ (C_3H_7OH)	2·0
Butyl „ (C_4H_9OH)	3·0
Amyl „ ($C_5H_{11}OH$)	4·0

Thus amyl alcohol would appear to be more toxic than butyl; butyl than propyl; and propyl than ethyl, etc.

Other observers on same action.

Other observers (7) have given the following amounts as relative toxicities (minimum lethal doses) *on rabbits and guinea-pigs*:—

	grams per kilo of body weight
Ethyl alcohol	7·75
Ethers	4·0
Aldehydes	1·0
Higher alcohols	1·4*
Furfural	0·24

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* The comparison in this case is of little value, as the proportions of the various higher alcohols given are not stated.

Vandevelde working on a variety of one celled *microscopic* organism found the following "toxic quotients":

Ethyl Alcohol	1·0
Propyl "	3·7
Isobutyl "	5·6
Amyl "	10·5
Aniseed oil	10·0
Peppermint oil	60·0

Vandevelde's work.

His method of working on microscopic organisms cannot be accepted as being closely applicable to the conditions under which these substances act in the case of the higher animals and man after absorption from the digestive system into the circulation.

Rabuteau (8) concluded that the higher the molecular weight the more poisonous were the higher alcohols (experiments on frogs and guinea-pigs). He thought that the by-products, and not the ethyl alcohol, were the poisonous factors.

Dujardin-Beaumetz and Audije's researches.

Dujardin-Beaumetz and Audijé (9) experimented on pigs* with beet, potato or corn-spirits which were given along with food. Later, pure ethyl alcohol was given.

	Grams per kilo of body weight.
Ethyl alcohol killed in doses of	5 to 6
Propyl "	3 to 8
Butyl "	1 to 8
Amyl "	1 to 5

They concluded that all alcohols are poisonous, but that the higher the molecular weight and the greater the solubility, the more poisonous is the particular alcohol; and that the presence of aldehydes and ethers increases the alcohol's poisonous action. They continued their experiments on pigs for nearly three years and concluded that the slow-continued administration of alcohols caused definite morbid changes in the digestive organs, liver, lungs, blood-vessels, etc. Again, after 30 months' administration of alcohol quite free from by-products (? if it were possible at that time to obtain this), the morbid changes were "insignificant and indistinct," while with the raw or badly purified spirits the abnormal changes appeared in a few months. They "lament that their results were so small compared with the time and labour expended on the experiments," but believe that the poisonous effects of spirit-drinking are due to the slow accumulation in the system of the by-products.

Brockhaus.

Brockhaus (10) experimented with aldehyde, paraldehyde, acetal, propyl alcohol iso-butyl and amyl alcohol, and concluded that the impurities of potato-spirit exert an incomparably stronger action on the human organism than does ethyl alcohol; and that the impurities in ordinary kinds of spirit play an essential part in the development of diseases due to drinking.

Brockhaus (on himself) (11) further found that aldehyde had a very irritant action on the mucous membranes of the stomach and bowels and of the lungs and that it "finally acted on the nervous system."

French Commission appointed in 1870.

A French Commission (12) in 1886 considered that the higher alcohols ("fusel oil") were the injurious ingredients in spirits made from grapes, beetroot, corn and potatoes; and they advised careful rectification of all spirits.

Boutigny, etc.

Boutigny (on himself), (13) *Poggiale* (on dogs) (14) and *Lussanna* and *Albertoni* (15) observed the injurious effects of ordinary aldehyde (acetic aldehyde) and the latter observers found 30 centigrams per kilo of body weight intoxicating and 70 centigrams per kilo fatal (the doses being injected into the veins).

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* The pig and man are stated to be the only creatures which willingly take alcoholic liquors with their food. In man, however, the habit has to be acquired, for instinct produces a disinclination to alcohol, *e.g.* on first indulgence.

Husz and Dahlström.

Husz and *Dahlström* (16) concluded that in dogs to which—

(*a*) pure alcohol* and then

(*b*) alcohol *plus* fusel oil were given once a day for 8 months no difference in the results could be noticed. The latter fed a dog for seven weeks on bread pills containing doses ranging from 4 to 120 drops of "fusel oil" alone. No poisonous effects resulted, and at the end of the experiments the dog remained healthy and, on being killed, no morbid changes were to be observed.

Husz also experimented on human beings, "but only in small doses and during short periods." Doses of $\frac{1}{8}$ to $\frac{1}{2}$ grain of "fusel oil" caused no other symptom than a feeling of warmth in the stomach. From 1 to 2 grains caused nausea, tightness of the chest, occasionally giddiness. Three to four grains caused a sense of burning in stomach and bowels, vomiting, colic and diarrhœa†.

Fusel would then become too repulsive to the persons experimented on so that the smell of it alone made them ill. These persons were not accustomed to take alcohol.

Husz pointed out that the amount of fusel oil in spirits is too small to cause the symptoms of alcoholism, and he concluded that these were due to alcohol (ethyl) principally and that the fusel may "possibly increase or hasten the action of the alcohol." These experiments have received support from those of various later observers and in general our work here leads us to somewhat similar conclusions.

Stenberg.

Stenberg (17) found that raw and purified spirits had the same kind and intensity of intoxicating action (experiments on rabbits).

Hamberg.

Professor Hamberg (on himself) (18) found that ethyl alcohol alone causes the injurious effects of abuse of brandy and malt liquors. For several weeks he took "aldehyde" in various proportions and various constituents of fusel oil, with and without ethyl alcohol, with no results.

Strassmann.

Strassmann (on dogs) observed that 3 per cent. of amyl alcohol added to "spirit" considerably increased the symptoms of alcoholism, and reduced the fatal period by half. One per cent. of amyl alcohol made certain symptoms more pronounced and hastened the approach of death. He concludes "that neither clinical experience nor experiments on animals have ever proved that a spirit containing 300 to 500 milligrammes of higher alcohols per 100 cubic centimetres of alcohol has a worse effect than the same amount of a pure spirit".

(This latter statement is entirely borne out by our experiments).

Allen.

Allen (19) took for three weeks a wineglassful of whisky, with $\frac{1}{2}$, 1 and later 2 per cent. of fusel oil. It was merely nauseous.

Brunton and Tunnicliffe.

Lauder Brunton and *Tunnicliffe*, in two papers published in the "Lancet" respectively in 1900 and 1902, dealt with the action of the aldehydes, and especially of furfural (furfuraldehyde). They experimented on cats, dogs, rabbits and on two men; and found that furfural in doses of from 0·1 to 0·05 gram (presumably per kilo. of body weight though not so stated) *injected under the skin* caused paralysis, convulsions (ascribed by them to asphyxia) and rapid and irregular breathing. These symptoms were very transient. "Immediately after the injection of the drug the animal would fall down completely paralysed, its tongue and lips would become bluish and its breathing sometimes very slow and convulsive and at other times irregular and rapid, it would then pass into a stage of........, convulsions, in many cases it would vomit, and finally would begin to recover, being at first dazed and rapidly becoming apparently normal. The whole cycle of symptoms would often be completed in twenty minutes to half an hour". "Almost identical symptoms were produced when the substance was given by the stomach mixed with milk or water in doses of about 0·5 gram in cats. The effect of the drug was less marked when given with milk and much more marked when administered upon an empty stomach." Larger doses than 0·5 gram (presumably per kilo.) killed. Two men who took 0·1 gram of furfural two hours after lunch suffered from neuralgic pain and sense of pulsation in the vessels of the head. A dull headache ensued in one case for the rest of the day. Experiments on animals with pure spirit and with spirit containing aldehydes were made and after the latter alone there occurred restlessness, discomfort, bad temper and loss of appetite.

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* The purity of the alcohol is open to much doubt as at this date the methods for obtaining pure alcohol were very defective.

† Fusel oil was probably given undiluted here, as in our experiments with much larger quantities *freely diluted* no such results occurred.

They further remark that "the amount of fusel oil calculated as amyl alcohol present in whiskey, whether raw or matured, is practically always under 0·1 per cent., and it thus follows that, although these higher alcohols are much more poisonous than ethylic alcohol, yet nevertheless in the quantities present they would, under ordinary circumstances, hardly affect to an appreciable degree the action of the spirit". They consider that aldehydes are probably much more injurious and they add :—

"The fact that different kinds of alcoholic drinks produce when freely imbibed different mental states—gay, sad, maudlin, etc., also points to the conclusion that it is probably the by-products contained in spirituous drinks rather than the ethylic alcohol itself, which give the special timbre to the mentation of the drinker or drunkard". They also consider that violent purposeless crimes committed under the influence of impure spirits would appear to be due to the impurities rather than to the ethyl alcohol.

Friedenwald.

Friedenwald (20) experimented with alcohol on 120 rabbits over a period of several years. The smallest weekly dose was 20 cubic centimetres and the largest 50 (say, 16 to 40 grams of absolute alcohol). A marked difference in the susceptibility of different animals was observed, some dying after a few doses, others surviving for years. *Post-mortem* examination showed fatty degeneration of the heart which was absent in animals killed after cessation of the use of alcohol, thus showing that it was not a permanent condition. Fatty disease of the liver and kidneys was also observed. Congestion (and in a few cases ulceration) of the stomach was common. A very marked atrophy of the nerve cells of the surface of the brain was usually to be observed. The above long series of experiments, therefore, add little to what was known previously and are thus chiefly of confirmatory value.

References.

(1) Taylor's "Poisons", 3rd ed., 1875, page 635; and other authorities cited in Appendix I to Playfair Commission's Report.

(2) Hale-White's "Pharmacology", 1901, page 106 *et seq.*

(3) Binz, Virchow's Archiv, 1870, Bd. 53, S. 529.
Strassmann, Arch. f. d. g. Physiol., Bonn, 1891, Bd. 49, s. 315.

(3*a*) Kraepelin, u. d. Beeinfl. emf. psychïscher Vorgänge d. e. Arzneimittel, 1892.

(4) Brit. Med. Journ., Vol. I, 1905.

(4*a*) U. d. Einfluss d. Alk. a. d. Emfindl. d. thierischen Körpers f. Infectionstoffe, (Zeits. f. Hygiene, Bd. XXIV, H. 2, B. 206, 1900.

(5) Constatt's Annual, 1844, Vol. iv, 1845, page 271.

(6) *Vide* (2).

(7) Quoted in Mr. Weinberg's Report on Assam out-still liquors, 1904.

(8) Report of International Congress for study of Alcoholism at Paris, 1878 (Paris 1879, page 50).

(9) Rech. exp. sur la puissance toxique des alcools (Paris, 1879): and Rech. exp. s. l'alcoolisme chronique (Paris, 1884).

(10) Studies on the poisonous nature of the impurities in potato-spirit on human beings, original researches by Dr. Brockhaus, of Godesberg.

(11) Loc. cit., page 152.

(12) Bulletin de l'Academie de medicine, 1885, Vol. 16, page 10.

(13) Comp. Rend. 1847, page 904.

(14) Ebenda 1848, page 337.

(15) Sull' alcool, Sull' aldeide, &c., Lo experimentale 1874, page 753.

(16) " Chronische Alkoholkrankheit ".

C. E. Fritze, Stockholm and Leipsig, 1852.

(17) Archiv, f. exp. Path., X, page 356.

(18) Baer, " Physiological experiments with volatile substances occurring in brandy", Vienna, 1884.

(19) Allen's " Comm. Organic Anal.", Vol. I, page 154.

(20) Journ. Amer. Med. Assoc., Sept. 9th, 1905.

CHAPTER VI.

THE EXPERIMENTS AT KASAULI.

Methods employed.

Primary object of "Physiological" work of this Investigation.

The primary object of the "physiological"* work of this Investigation was to ascertain whether the *quantities of by-products found in alcoholic liquors* had the effect of markedly increasing or altering unfavourably the action of the alcohol; and, if so, which of these was responsible for such effect. That is to say, it has been an investigation of the *noxiousness* of the various ingredients of alcoholic liquors *and not of the physiological action as such.* The next step would have then been to fix standard-limits (permissible maxima) for such ingredients. It was also thought necessary to investigate, *as far as possible in the limited time at our disposal*, the inter-action of the by-products in order to discover any enhancing effects of certain combinations and proportions and also their modifying influence on the action of (ethyl) alcohol.

Comparative *noxiousness*, not "physiological action" to be investigated here.

Instrumental pharmacological records were out of the question in the limited time; and would besides have been of very doubtful use for the purely practical purposes required by Government. Observation of the symptoms produced by the administration of the various substances, singly and in different combinations, was the only practicable method to follow. The more practically important previous work on the subject has been similarly based on symptomatic, and not on instrumental, observations. At an early stage, we carried out a series of observations by means of clinical instrumental methods for recording alterations in blood pressure on men but the results were found not to be of sufficient practical interest to render it desirable to continue them.

Grouping of by-products as regards relative proportions.

The analytical records of the samples examined of the various kinds of spirits obtainable in India were first classified with the view of ascertaining the possibility of obtaining a grouping of the quantities of the various by-products present. These results have already been fully set forth in the chemical section of this Report.

Unit chosen.

With a view to ascertain the action of these *groups of by-products* in the varying amounts and combinations in which they occurred, they were administered to adult men as follows :—

Starting with the least quantity present of any group of by-products, an amount was administered corresponding to that present in an imperial quart (40 fluid ounces) of 60 U. P. spirit. This was taken as the fixed unit, as the *reputed* quart was found to vary in capacity (*e.g.*, from 24 to 27½ fluid ounces). The unit chosen thus formed a very severe standard as representing the amount of by-products contained in 40 instead of, say, 25 fluid ounces of 60 U. P. spirit. This standard had been fixed, and had been in use, for several months before I had received the replies to the questions (contained in my report No. 3 to the Excise Committee) from local officers all over India. From these it would appear that quarter to half a reputed quart bottle is *about the usual daily amount* of spirit consumed all over India. This would represent from 6 to 12 ounces of spirit (of various strengths) daily. The severity of my standard becomes specially apparent from this, seeing that the amount of by-products consumed in 40 ounces has been adopted as the fixed unit. The strength of spirit (60 U. P.) was chosen as being perhaps the most usual strength drunk "neat" all over India.

By-products' action investigated singly and in various combinations on men.

The by-products are analytically estimated *in groups* so that, for instance, the expression "aldehydes" refers to a mixture of several different aldehydes. It was thus necessary to examine singly *and*

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* The description "physiological" for this section of the work has been adopted as the most convenient and as perhaps more generally conveying the idea of the nature of the experiments.

in various combinations such of these different aldehydes found in spirits as were available for this purpose.

Experiments were made with gradually increasing amounts of the particular by-product or group of by-products until the maximum amount found on analysis had been given, thus comparing their noxious effects (if any).

Action on men observed of by-products in known amounts when added to fixed moderate amounts of "pure" alcohol.

Next the noxious effects (if any) of the by-products on men were compared with the effects of pure alcohol alone. Then the action on men of combinations of different by-products, when given with and without standard doses of pure alcohol, was observed. For instance, a known amount of the different aldehydes found in spirits would be added to a known amount of amyl alcohol (ordinarily the chief constituent of "fusel oil"), administered, and any noxious effects noted. Then the same experiment would be repeated but modified by the addition of a fixed amount of pure (ethyl) alcohol.

Maximal amounts found of each by-product were combined and administered with and without alcohol, to adult men.

In this way, the various combinations of by-products were administered until the maximum amount of each by-product present had been given together. This, of course, was a very severe test for in no spirit is the *maximum amount of all the various by-products present.* But results obtained in this way—especially if negative—are all the more convincing as showing the practical negligibility of the action of the by-products of spirits.

Summary of combinations given to men.

The combinations given to men may thus be briefly summarised :—

(1) By-product given alone : In the case of aldehydes, ethers, "fusel oil" and volatile oils each constituent of the group was given singly, as far as possible.

(2) By-product given along with each of the other by-products in various doses and progressively until the *maximum* amounts of all the by-products had been administered at the same time.

(3) The single by-product, in large doses, given along with a standard quantity of pure alcohol (*i.e*, 1 to 2 ounces of absolute alcohol).

(4) Various combinations (" maximum," " high " and " medium ") of by-products given with standard quantities of *pure* alcohol.

(5) Experiments made with standard quantities of *pure alcohol* alone (*i.e.*, containing no by-products).

Administration to men continued in certian cases for several days consecutively.

Not only has the action as regards producing noxious effects of these substances (alone and in varying combinations, with and without pure alcohol, and also of pure alcohol alone) been observed on men in single doses but also, as far as at all practicable, their continued action for several consecutive days. This with the view of observing the effect of continued administration with reference to any cumulative action ; or, on the other hand, to the establishment of *tolerance* to the effect of the various combinations of by-products, with and without alcohol. As these observations were made on human subjects the results should prove of much practical importance.

It was, of course, quite impracticable to study *on men* the effects of the administration of the by-products (with and without alcohol) *for very long periods* as serious impairment of health would have been likely to result, *if only from the continued action of the alcohol.* Nor, in any case, was the time available nearly sufficient for such experiments, even on animals, as at least two or three years' work would have been necessary. Such previous work as that of Dujardin-Beaumetz and of Friedenwald indicates that the results obtained are in no way commensurate with the time and labour expended. Furthermore, the facts ascertained in the course of this enquiry appear to be quite sufficient for the present entirely practical purposes of Government.

Determination of minimal toxic doses of by-products and of alcohol.

The minimal toxic dose *by the mouth* (that is, about the smallest amount required to produce definite symptoms) was determined on animals where practicable for the chief by-products of spirits.

Previous observers have chiefly worked at the minimum *lethal* doses of by-products, *i.e.*, the least amount that will kill the animal.

The method I have adopted, namely, to ascertain the minimal *toxic* dose, is best suited for the practical purposes of this Investigation.

In this way, some idea was formed of the relative potency of the various by-products.

Modifying action of pure alcohol on minimal toxic doses of various by-products.

Then, again, the modifying influence of the different by-products on an approximately minimum toxic dose of pure alcohol was observed in order to ascertain whether the by-products increased or lessened the action of a dose of alcohol sufficient to produce marked symptoms.

Control of identity and purity of samples used and of solution-strengths.

The chemical identity and purity of the by-product examined were previously tested as thoroughly as possible.

This is a point apparently too often omitted in work of this kind as no doubt it must often be found a difficult matter to arrange to have the necessary chemical work carried on side by side with the physiological work.

But unless it is done one can have no certainty as to the identity of the substance with which one is working and of the actual proportions used. For example, had I accepted as chemically pure the by-products sent out as such by several of the best Berlin and London firms my results would necessarily have proved misleading. For, on analysis, the so-called " pure " by-product was found to contain a by no means negligible proportion, say, of alcohol or water. This would, therefore, dilute the by-product correspondingly so that the strength of solution administered would really have been much less than what it was supposed to be.

Therefore, each substance used was fractionally distilled (many of these operations took several days to complete) and its fixed boiling point and density were ascertained along with other distinctive characters. Then a solution of the required strength was prepared by accurate weighment on a chemical balance ; and, lastly, in order to make quite sure that it was actually of the proper strength, the solution to be administered was in the most important cases *analysed quantitatively* in order to see whether or not it contained the amount of the by-product it was believed to do.

The substances used for experiment were given either undiluted or diluted with distilled water. In a few cases alcohol (as dilute as possible) had to be used to dissolve some of the by-products as water was insufficient; but in by far the majority of cases distilled water alone was used. In the important cases of, for instance, furfural, acetaldehyde, amyl alcohol and pure (ethyl) alcohol, water was the only solvent employed.

Methods of administration and precautions observed.

The method of administration of the substance was, wherever possible, by the mouth (rather than by hypodermic injection) as being the most practical. A substance administered by the stomach may be modified in various ways by the digestive juices and otherwise, and its action may thus come to be altered, especially in the case of such more or less complex organic substances as spirit-by-products. The action when given hypodermically is, with most physiologically active substances, greatly increased so that correspondingly smaller amounts have to be given than when administered by the mouth. *The method of administration adopted in the case of dogs* was to pass into the stomach a soft rubber tube through which the substance to be administered was poured. This method was necessary as dogs refuse to take such substances even along with food and it was desirable to give the substance *on an empty stomach.* Aldehyde, however, could not be given by the mouth in the necessary quantities as it was quickly vomited, so that it was necessary to resort to subcutaneous injection in its case. Even this did not overcome certain difficulties as will be observed in the detailed account of the aldehyde experiments. As time was limited and in view of the special difficulties of administration (even hypodermically) the action of aldehyde *on animals* could thus not be fully worked out.

The administration was always on an empty stomach. At least two days and often a very much longer period were allowed to elapse between each experiment in order to allow elimination of the previous dose; also to help to lessen tolerance, or the effect of any irritation produced on the stomach, etc.

In the human experiments, the substances were given in watery or alcoholic solution and in no case hypodermically. Most of these by-products, especially in the larger amounts, were very nauseous, so that "getting them down" was a process not by any means fraught with pleasant anticipations or realisations.

Doses in animals proportioned to body weight.

The doses given to animals were proportioned to body-weight, *i.e.*, a fixed quantity of the by-product was given for each kilogram of the animal's body-weight. It is only in this manner that such experiments on animals can be made comparable. For example, a dose of a powerful drug that will cause marked symptoms in a subject of light weight is likely (other things being equal) in a much less degree to affect another of double the weight so that the necessity for proportioning dosage to body-weight will be evident.

Systematic reweighments of animals.

Of course, it was necessary to weigh the animal employed *before each experiment* so as to be able to calculate the correct dosage of any substance in relation to its *body-weight*, which relation is essential for comparative purposes.

Control experiments on animals.

In order to more effectually check the action of the substances given the following routine procedure was followed in all comparative experiments on animals. For example, two dogs were given, in the one case, a certain dose of a by-product or combination of by-products along with pure alcohol; and, in the other case, the same dose (per kilo) of pure alcohol alone. The effects were noted and then, after an interval of a day or two, the experiments were repeated but in the reverse way, *i.e.*, the dog which had taken pure alcohol alone previously was given the alcohol *plus* the particular by-product under observation; and the other dog got only the pure alcohol, the dose per kilo being the same as before. In this way, control was exercised as regards individual variations in reaction to the substance administered. (*This explains the bracketing employed in the last columns of the Tables which follow.*)

"Absolute" doses given to men.

The human experiments being conducted with such *comparatively small amounts* of by-products on *adult* men and only with a view to elicit any slight noxious results and without any attempt whatever to ascertain their physiological action as such on human beings, the doses given were "absolute" and so irrespective of body-weight.

Tolerance, cumulative action and individual susceptibility.

As well as the effects of tolerance and individual susceptibility those resulting from the cumulative action of the substance administered had to be watched and as far as possible allowed for. For example, a small fixed dose of a substance may be given for several successive days without any apparent effect but one dose extra may induce marked symptoms which are due to the fact that some of the substance has remained behind in the system and has gradually accumulated so as to give the effect finally of a large dose.

Precautions in connection with human experiments.

Where necessary, the substances given were first administered in varying doses to dogs before a human experiment was made in order to prevent any chance of untoward symptoms in the human subject.

Subjects used for experiments.

The experiments with dogs have formed an important but still subsidiary part of the "physiological" work. Dogs were principally used for the observation of the action of the by-products in quantities largely exceeding those ever found in spirits. But only comparatively gross symptoms can be observed in dogs so that it was necessary to supplement the observations made on them by human experiments as far as practicable.

The practical object in view throughout was to observe any noxious effects of such quantities of by-products as are found in practice. Such small amounts were only likely to produce "minor symptoms" and hence could alone be elicited in the case of men. Furthermore, a large number of such experiments had to be done in a very limited time. It was thus necessary to use as many human volunteers as possible and at the start of the work a few coolies (*all of whom were accustomed to the occasional use of alcoholic liquors* and were found to be in good health) were employed to supplement the European staff of the Investigation who had volunteered for this very unpleasant work. As soon as the matter came to their notice, however, the Government of India decided that it would be undesirable to employ any natives of India or British soldiers as "volunteers" for this purpose, even although no risk to health was involved. So that the most important experiments were restricted to our European Laboratory staff. This has, of course, proved a very considerable difficulty, especially as all our other work had to be carried on at very high pressure on account of its quantity, difficulty and the limited time allowed for its completion.

It is believed that by means of these human and animal experiments sufficient practical information as to the general effects of the various by-products found in spirits has been obtained to permit definite conclusions to be formed as to their relative noxiousness or otherwise.

Explanation as to strengths of solutions employed.

N.B.—1. In the following records of experiments, where *percentage strengths* of alcoholic solutions are mentioned it is to be noted that these are calculated as weight per volume (grams per 100 cubic centimetres).

2. Doses of "absolute alcohol," expressed in cubic centimetres, mean this amount of 100 per cent. alcohol suitably diluted.

3. Where not otherwise mentioned, alcohol has been administered in the case of dogs in 30% solution (weight by volume).

FURFURAL.

The case of furfural is of special practical interest to us as this is the by-product which (along with acids) occurs in relatively larger amounts in Indian-made spirits than any others.

Effects of furfural on animals in large doses.

Furfural when given to animals in what are (relatively to the amounts found in alcoholic liquors) enormous doses produces death or very severe symptoms such as rapid paralysis, great interference with respiration and general convulsions. *Doses, however, which would produce any such symptoms are never remotely approached in the case of alcoholic liquors.* (And of course, an *excessive* dose of pure alcohol alone will kill).

FURFURAL EXPERIMENTS.

Human experiments with furfural.

To human subjects in 25 cases, amounts ranging from 0·0026 to 0·95 gram (absolute dose) of furfural *alone* have been given without producing any appreciable result. Also 0·95 gram of furfural with 30 grams of absolute alcohol was taken by one of us without noxious result.

Furfural has also been given to men in doses of 0·162 *and 0·1 gram in various combinations with alcohol and the chief by-products* in proportions such as occur per imperial quart in the worst spirits analysed by us.

From the details in the tables it will be seen that there were no noxious results from the amounts given to men.

Significance of the human experiments.

The largest amount of furfural found in any liquor analysed here is 0·093 gram per imperial quart of 60 U. P. spirit. Therefore, ten times more than the amount present in this very exceptional sample is found to be without noxious effects.

74 % of the Country Liquors contained amounts of furfural varying from 0·0026 to 0·026 gram per imperial quart of 60 U. P. So that about 360 and 36 times, respectively, of these amounts have been taken without harmful results.

Large amounts of furfural produce severe symptoms.

Definite symptoms to be presently detailed result when furfural is given alone to animals by the mouth (in an 8 % watery solution) in doses of 0·38 to 0·04 gram *per kilo of the animal's body weight.* This would mean a total dose of about 3·8 to 4·1 grams to a medium sized dog weighing 10 kilos (about 22 lbs.)

Observations regarding the modifying effect even of small amounts of alcohol on action of relatively large doses of furfural.

We have, however, found that alcohol exerts a marked modifying action on certain symptoms produced by large amounts of furfural when given alone. When a large dose of furfural alone is given to dogs (*e.g.*, 0·46 gram per kilo) by the mouth severe convulsive symptoms result. When the same dose of furfural is given along with even so small an amount of ethylic alcohol as 0·75 to 1·2 c.cs of absolute alcohol *per gram of furfural given*, then the *convulsive* symptoms of furfural are prevented from developing. But as regards the *paralysing* action of furfural the alcohol does not appear to exert any "antidotal" action.

Illustrative experiments to prove this action.

An example of such experimental results may be shortly given here :

(*a*) 0·45 gram of furfural per kilo (or a total dose of 5·9 grams in this case) along with 4·425 c.c. of absolute alcohol (*i.e.*, 0·75 c.c. for each gram of furfural administered) is given by the mouth to a dog.

Results.—No convulsive symptoms occur, but the loss of muscular power etc., occurs as with furfural alone.

(*b*) The same dose of furfural *alone* or even a smaller dose (*e.g.*, 5·08 grams altogether) is given by the mouth to the same dog (or to others in corresponding amount) some days before or after experiment (*a*).

Results.—Convulsions as well as the other symptoms (paralysis, &c.) of severe furfural poisoning occur.

Such experiments were repeated many times (in order to avoid all possibilities of fallacy) with a like result.

The inference is clearly that alcohol exerts a certain amount of antidotal action as regards furfural, *removing its convulsive symptoms but not its other effects*, *e.g.*, *paralysis*, *&c.*[*]

Large doses of furfural found to increase the paralysing action of alcohol.

The converse case was also examined, *viz.*, the modifying influence of furfural on alcohol.

Furfural was given by the mouth to dogs in doses of 0·05 to 1·221 gram per kilo of body-weight along with alcohol in rather more than the latter's minimal toxic dose (1·9 to 2·2 grams of absolute alcohol per kilo). When 0·15 gram per kilo of furfural had been given with the above amounts of alcohol, the alcohol's action was found to be supplemented by the paralysing action of furfural. Below 0·12 gram of furfural per kilo, no difference was to be observed.

On the whole, these animal experiments with small doses of furfural and large doses of alcohol show that the effects of the alcohol are chiefly enhanced by the paralytic or paretic action of the furfural.

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[*] Experiments have not been conducted, owing to lack of opportunity, to ascertain if alcohol would prevent death when administered with a minimum lethal dose of furfural.

Practical significance of these results.

That is to say, that a dose of pure alcohol insufficient in itself to produce paralysis and insensibility may, if given along with a sufficient amount of furfural, produce both paralysis and insensibility. This additional action of furfural was not observed till the amount given *even per kilo of body weight* (together with the alcohol) exceeded the *absolute* amount of *furfural* that would be taken by a man in an imperial quart of 60 U. P. liquor containing the highest amount of furfural found on analysis by us.

For example, additional effects were not noticed till 0·1 gram of furfural per kilo of body weight (in this case a total dose of 0·601 gram) was added to the alcohol. Now the largest amount of furfural ever found by us was only 0·093 gram per imperial quart, which is slightly less than the amount given *per kilo* of body weight and *nearly seven times less* than the total dose necessary in this case to produce these additional effects.

CONCLUSIONS FROM FURFURAL EXPERIMENTS.

Conclusions from furfural experiments.

Considering the absence of noxious effects in the human experiments with doses of furfural larger than have been ever found by us in spirits and further having regard to the fact that definite symptoms in dogs have only been produced in amounts far exceeding the quantities found on analysis, the conclusion that appears to be justified is that furfural, although in itself a powerful poison, is *in the amounts in which it occurs in potable spirits*, practically unimportant as regards noxious action.

The following tables and explanatory notes show in detail the experimental basis on which the foregoing statements have been founded:—

TABLE I.

ANIMAL EXPERIMENTS.

Furfural alone (8 per cent. solution in distilled water) given by the mouth.

Where vomiting occurred within 10 minutes, but not before 6 minutes, the case is included. Cases with early vomiting (before 6 minutes) are omitted.*

	Doses per kilo in grams.	Absolute doses in grams.	Result.
	0·27	2·8	*Nil.*
	0·29	3.5	*Nil.*
2 separate experiments made	0·34 Slight vomiting between 6 and 10 minutes of administration.	3·8	Slight symptoms *
	0·35	3·6	*Nil.*
	0·38	4·2	Marked symptoms.
	0·38 Slight vomiting 6-10 minutes after dose.	6·02	"
	0·40 Slight vomiting 8 minutes after dose.	5·02	"
	0·41	4·5	"

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* The symptoms produced in cases in which vomiting occurred after 6 minutes showed in general little difference in degree to those in which no vomiting occurred, and are hence included.

DETAILED EXPLANATION OF ABOVE TABLE: SYMPTOMS IN ORDER OF OCCURRENCE.

Furfural given by the mouth to Dogs.

Absolute dose given, 3·8 to 6·0 grams; or 0·34 to 0·41 gram per kilo of body weight.

IN THE SMALLER DOSES (*e. g.*, 0.34 gram per kilo): rapid, profuse and continuous salivation quickly resulted.

In about 5 minutes: definite muscular weakness (paresis), steadily increasing and ending in entire loss of muscular power with complete flaccidity; respiratory movements become irregular, paroxysms of rapid breathing.

In 5 to 8 minutes: facial twitchings. Continued spasms (tonus) of limbs with jerking convulsive movements (clonus) of jaws in from 6 to 7 minutes (sometimes not till 12 minutes). Violent retching and vomiting. Defœcation and micturition.

In 12 minutes: spasmodic inspirations usually.

In 27 minutes: jerking (clonic) movements of head.

In 20—30 minutes: sudden recovery. Animal suddenly gets up and walks about.

IN THE LARGER DOSES (*e.g.*, 0·40 gram per kilo)—

Salivation as above.

In 4—5 minutes: partial loss of muscular power going on to definite paralysis. Micturition, defœcation, retching and vomiting (as above).

In 6—7 minutes: respiration very irregular in rate and depth; general convulsions (tonic and clonic) with jerking movements (clonus) of jaws; often twitchings of leg muscles.

Convulsions appear to be produced by a direct action of the furfural on the nervous system. In our experiments the convulsions were not produced by any actual asphyxial condition though at the time of their occurrence and for a short period afterwards they were associated with cyanosis (blueness of lips, etc.). This last was due to respiratory embarrassment, chiefly due to spasm of the respiratory muscles, though the respiratory centre is also early and markedly affected prior to the onset of convulsions (as is shown by the early irregularity in rate and depth of respiratory movements). It may be noted that tonic muscular spasms, *e.g.*, of hind limbs, may occur quite apart from any general convulsions.

In 10—12 minutes: spasmodic inspirations; very marked and prolonged jerking (clonic) convulsions occur followed by prolonged general muscular spasms (tonic contractions).

In 15—25 minutes: rapid jerking movements (clonus) of head and jaw.

In 20—40 minutes: sudden recovery.

The following facts were also noted:

Food is generally taken at once, and always within about an hour.

The *prolonged* general (clonic and tonic) convulsions are not repeated even in the larger doses. Sometimes "swimming" movements of legs occur in 7—12 minutes, and these occasionally were prolonged and marked. Sometimes there was marked forcible expiration. The spasmodic character of the inspiratory movements was often marked. The twitchings of the face muscles were not noticed with the larger doses. The jerking (clonic) movements of the head when recovery was occurring were often very marked and seemed to be induced by the animal trying to lift its head. Furfural was found to be *excreted unchanged in the urine* in small amounts.

THE FOLLOWING TABLE AND DESCRIPTION OF THE EFFECTS *of furfural when given hypodermically* are here annexed in order of occurrence.

TABLE II.

EXPERIMENTS ON ANIMALS.

Furfural given alone (*5 per cent.—8 per cent. solution in water*) hypodermically (*to dogs where not otherwise mentioned*).

Dose in grams per kilo.	Actual dose in grams.	Symptoms produced.
0·022	0·4	*Nil.*
0·027	0·5	*Nil.*
Cat ... 0·036	0·1	*Nil.*
0·038	0·45	*Nil.*
0·040	0·7	Slight.
Kitten ... 0·049	0·06	*Nil.*
Cat ... 0·054	0·15	Slight.
Kitten ... 0·060	0·075	*Nil.*
Cat ... 0·073	0·2	Slight.
0·076	0·15	Slight.
Cat ... 0·090	0·25	Marked.
Kitten ... 0·160	0·2	Marked.
0·163	2·0	Marked.
0·200	2·21	Marked.
0·208	2·5	Marked.
0·316	3·5	Very severe.

TOXIC SYMPTOMS IN ORDER.

Hypodermic administration of Furfural to dogs.

Symptoms commence in from 5 to 6 minutes. Muscular weakness, producing staggering and going on to complete loss of muscular power with entire flaccidity. Defœcation, Micturition. Profuse salivation which mostly continues throughout course of symptoms. Hurried respiration. Vomiting. General convulsions associated with (tonic) spasms—general and local, and with general tremors. (Tremors not seen at this stage with the larger doses.)

Often a continued spasm (tonus) is to be seen, as evidenced in the limbs. Spasms are sometimes especially marked in the face-muscles. Respiration irregular in rate and depth (marked prolongation of expiration noticed in many cases): very hurried at times. Blueness of lips, tongue, etc. (cyanosis), apart from convulsions, was only noticed with large doses (*e.g.*, 0·16 gram per kilo). Pulse weak, irregular and very rapid after convulsions. Fine tremors at first general, and later seen only in head, and associated with occasional twitchings. The tremors persist long after the loss of muscular power (paresis) is recovered from. The animal refuses food for some hours after a large dose.

Drowsiness, probably chiefly from exhaustion; symptoms last ½ to 1 hour according to dose.

Marked sweating of paws (cat and dog) was noticed in several cases but not in all.

Pain seemed to be produced towards the end of the experiment with the larger doses (dogs whining much then as if in pain).

Slighter symptoms with smaller dose, e.g., 0·04 gram per kilo (see Table II): slight muscular weakness; fine tremors, especially in head; breathing shallow, quickened for a short while, and irregular.

In view of certain statements of other observers the following negative results are recorded:—

Negative results.—No immediate onset; no blueness of lips, (cyanosis) except in large doses—apart from convulsions. No loss of corneal reflex.* No general loss of sensation (anæsthesia). No loss of appetite after symptoms have passed off in *small* toxic doses; but with large toxic doses appetite is lost. No loss of consciousness.

The following Table III shows *the effects of combined doses of furfural and (pure) alcohol on dogs, i.e.*, the *additional* effects produced by giving furfural along with pure alcohol.

It has already been noted that in this and succeeding Tables the bracketed results in the last column refer to comparisons made on two subjects—each in turn being used as the "control."

TABLE III.

ANIMAL EXPERIMENTS.

Furfural + Alcohol: Administration by mouth.

Action of furfural plus alcohol.

Results *compared with those with similar amounts of pure alcohol* as controls on two dogs, the experiments being repeated, reversing the respective doses per kilo. Alcohol given in 30 per cent. (weight per vol.) solution.

Dose per kilo in grams.	Absolute dose in grams.	*Resulting difference in the case of the furfural mixture.*
Furfural + Alcohol.	Furfural + Alcohol.	
0·05 + 1·9	0·4275 + 16·245	Staggering gait not increased.
0·05 + 1·9	0·5215 + 19·817	
0·05 + 2·2	0·7905 + 34·782	*Nil.*
0·05 + 2·2	0·6375 + 28·05	
0·08 + 2·0	0·8344 + 20·86	*Nil.*
0·08 + 2·0	0·6392 + 15·98	
0·1 + 2·0	0·601 + 12·02	Very slightly more marked staggering gait.
0·1 + 2·0	0·606 + 12·12	
0·1 + 2·1	1·944 + 40·824	*Nil.*
0·1 + 2·1	2·086 + 43·806	
0·1 + 2·1	0·601 + 12·621	*Nil.*
0·1 + 2·1	0·833 + 17·493	
0·12 + 2·1	1·5912 + 27·846	*Nil.*
0·12 + 2·1	1·4892 + 26·061	
0·12 + 2·1	1·5576 + 27·258	Very slightly more marked staggering gait.
0·12 + 2·1	1·8768 + 32·844	

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* *Footnote.*—Corneal reflex.—When the white of the eye is touched, the animal involuntarily closes its eyes.

Dose per kilo in grams.	Absolute dose in grams.	*Resulting difference in the case of the furfural mixture.*
0·13 + 2·1	1·937 + 31·29	Staggering gait increased in degree.
0·13 + 2·1	1·6952 + 27·384	
0·14 + 2·1	1·8732 + 28·098	Ditto.
0·14 + 2·1	1·848 + 27·72	
0·15 + 1·9	2·346 + 29·716	One had general muscular paralysis and slight insensibility. Paroxysms of rapid breathing lasting a few seconds. After the muscular weakness had passed off (3½ hours after administration) there remained a more marked staggering gait.
0·15 + 1·9	2·0235 + 25·631	The other dog had very marked weakness in muscles; for a short while was paralysed: and was in a state of insensibility (light coma) for a time.
0·15 + 2·0	1·887 + 25·16	Staggering gait increased.
0·15 + 2·0	1·956 + 26·08	
0·15 + 2·1	1·827 + 25·578	No increase in staggering gait.
0·15 + 2·1	2·466 + 34·524	
0·16 + 2·1	2·24 + 29·4	Staggering gait more marked.
0·16 + 2·1	2·2864 + 30·009	
0·2 + 1·8	3·004 + 27·036	Staggering gait not increased.
0·2 + 1·8	2·936 + 26·424	
0·562 + 1·8	8·0 + 25·596	General muscular paralysis; loss of consciousness ("light coma"); animal looked very ill.
(Vomiting after 33 minutes.)		
Compared once only with alcohol alone		
1·221 + 1·9	5·815 + 9·044	General muscular paralysis: death after some nine hours.
(Vomiting after ½ hour)		
Compared once only with alcohol alone as animal *died*		

Details of furfural *plus* alcohol experiments.

THE FOLLOWING DETAILS WILL SERVE TO ILLUSTRATE THE ABOVE FIGURES MORE FULLY.

Furfural (0·05 to 1·221 gram per kilo) along with rather more than a minimal toxic dose of alcohol* (1·9 to 2·2 grams of absolute alcohol per kilo) was given to dogs by the mouth. When as much as 0·15 gram per kilo of furfural was given the additional effect was marked. In the smallest amounts of furfural given, no appreciable result followed. In the largest dose (1·221 gram per kilo) death occurred about nine hours after administration.

When 0·15 gram per kilo of furfural is given with an appropriate dose of alcohol, loss of muscular power becomes apparent in about eight minutes (the dog's legs "give way under it" and it rolls over and lies on its side instead of merely stumbling in its gait).

In about 20 minutes or sooner, muscular paralysis is much more marked and the animal cannot rise or stand when helped up.

In about 30 minutes, the animal lies quite flaccid and partly unconscious (stertorous breathing, much diminished corneal reflex, &c.) but can be very easily roused, relapsing, however, rapidly into its semi-conscious state. This condition would usually last about seven minutes. The other dog used for comparison in this experiment to which had been given the same dose (per kilo)

The dose of alcohol had to be increased in certain cases owing to some degree of tolerance to its action having been established.

of pure alcohol had merely a more or less staggering gait but no paralysis or insensibility.

To show the variability of action, the case of two dogs may be cited to which had been given the same doses as above with no increase or modification of action from the addition of the furfural. (No furfural had been given to them for two months previously so that the establishment of tolerance can scarcely explain the difference in this case.)

With other pairs of dogs, to whom were given 0·13 and 0·14 gram of furfural per kilo in addition to the alcohol, no marked loss of muscular power or tendency to unconsciousness (coma) was observed. But the paralysing action of the furfural was here indicated by the fact that the dog which had received the furfural *plus* alcohol fell over from time to time whereas the other dog which had been given the same dose (per kilo) of alcohol alone was only slightly unsteady in its gait. Furthermore, the dog to which furfural had been given had received, several days previously, the same dose per kilo of pure alcohol alone and had responded to its action normally.

In another pair of dogs with an addition of 0·12 gram (per kilo) of furfural to the alcohol the staggering gait was definitely increased; whilst in yet another pair of dogs there was no noticeable additional effect with these doses.

Below 0.12 gram of furfural (per kilo) *plus* alcohol, no additional effects were observable.

Again, the above-mentioned pair of dogs (which had marked additional symptoms with 0·15 gram per kilo of furfural *plus* alcohol) showed only a slight increase in staggering gait (ataxy) when given 0·13 gram of furfural. One of these dogs which showed the additional symptoms before mentioned with 0·15 gram furfural per kilo *plus* alcohol, had marked muscular paralysis lasting an hour and a short period of coma when 0·562 gram furfural per kilo was administered.

Another pair of dogs were given 0·16 gram (per kilo) of furfural and although loss of muscular power and increase of staggering gait were evident there was no tendency to loss of consciousness (coma).

Again, where a dog had been given (in addition to alcohol) furfural to the extent of 1·221 gram per kilo, no comatose condition resulted but muscular paralysis was very marked and persisted for about 45 minutes.

The following results illustrate the converse case, viz., *the effects of alcohol on the action of furfural*:

TABLE IV.

ANIMAL EXPERIMENTS.

To show the modifying effect of alcohol on furfural.

Where vomiting occurred within ten minutes (but after 6 minutes) the experiment is cited. Cases in which vomiting (which seems to be produced as easily as with furfural alone) occurred before 6 minutes are not included. The furfural was given by the mouth in 8 per cent. solution in water, the alcohol added being as strong as obtainable, usually about 90 per cent. by volume.

Dose per kilo of Furfural.	Absolute dose of Furfural and of Ethyl Alcohol.	Result.
0·4 gram	5·08 grams furfural + 1 c. c. absolute alcohol (0·19 c. c. absolute alcohol for each gram furfural).	Muscular paralysis; tonic and clonic spasms.
0·38 gram (slight vomiting in 7 minutes).	4·978 grams furfural + 2 c. c. absolute alcohol (0·41 c. c. absolute alcohol for each gram furfural).	Muscular paralysis; tonic spasms.

Dose per kilo of Furfural.	Absolute dose of Furfural and of Ethyl Alcohol.	Result.
0·45 gram. (1st experiment on this dog.)	4·4 grams furfural + 3·18 c. c. absolute alcohol (0·722 c. c absolute alcohol for each gram furfural).	Marked paralysis.
0·45 gram ...	4·7 grams furfural + 3·43 c. c. absolute alcohol (0·73 c. c. absolute alcohol for each gram furfural).	Ditto.
0·45 gram ...	6·9 grams furfural + 5·106 c.c. absolute alcohol (0·74 c. c. absolute alcohol for each gram furfural).	Ditto.
0·46 gram. (1st experiment on this animal.)	5·9 grams furfural + 4·425 c. c. absolute alcohol (0·75 c. c. absolute alcohol for each gram furfural).	Loss of power in muscles. Panting respiration.
0·45 gram. (1st experiment on this animal.)	5·9 grams furfural +4·425 c c. absolute alcohol (0·75 c. c. absolute alcohol for each gram furfural).	Loss of power in muscles.
0·4 gram* ...	5·08 grams furfural + 5 c. c. absolute alcohol (1·01 c. c. absolute alcohol for each gram furfural).	Ditto.
0·38 gram.† (1st experiment on this animal.)	6·0 grams furfural + 5 c. c. absolute alcohol (1·2 c. c. absolute alcohol for each gram furfural).	Ditto.
0·45 gram. (1st experiment on this animal.)	5·9175 grams furfural+4 c. c. absolute alcohol (1·47 c. c. absolute alcohol for each gram furfural.)	Muscular paralysis.

* This same dose per kilo of furfural *alone* in the same dog produced clonic and tonic spasms and tremors, as well as paralysis, etc. These symptoms also occurred when the absolute alcohol given per gram of furfural was 0·49 c. c. only.

† The same dose per kilo of furfural alone in the same animal produced clonic and tonic spasms as well as paralysis, *in spite of slight vomiting having occurred within 7 minutes of administration.*

Modifying action of Alcohol on furfural symptoms.

The above experiments were conducted in order to ascertain the amount of alcohol necessary to prevent the occurrence of the severe convulsive symptoms of furfural when given by the mouth in a dose large enough to produce such marked convulsive symptoms. It was found that if 0·75 to 1·2 cubic centimetre of absolute alcohol was given for each gram of furfural administered by the mouth no convulsive symptoms resulted. There was evidenced, however, loss of muscular power and the animal whined and barked as if in pain; and respiration was also affected in rate and depth. For example, a dog was given 0·38 gram of furfural per kilo (or 6 grams in the case of this particular animal) along with 5 c. c. of absolute alcohol (or 1·2 c. c. for each gram of furfural) and no convulsive symptoms occurred. Loss of muscular power, however, resulted as usual with furfural. Several days later the same dog was given the same amount per kilo of furfural alone and had marked convulsions as well as paralysis, etc. But if 0·4 gram per kilo of furfural (or 5·08 gram in this particular case) was given with only 0·19 cubic centimetre of absolute alcohol for each gram of furfural given, convulsions resulted as well as marked paralysis, etc. In this latter case, the dose of alcohol was thus too small to exert sufficient antidotal action on the furfural.

When as large a dose as 1·221 gram per kilo of furfural was given (in this case 5·815 grams absolute dose), slight tonic spasm occurred in the limbs, although absolute alcohol to the amount of nearly 2 c. c. for each gram of furfural was added to it. No actual convulsions occurred. The animal died after some nine hours. On the other hand, when as large a dose per kilo of furfural as 0·562 gram was given with 4 c. c. of absolute alcohol (for each gram of furfural) no convulsions or tonic spasms occurred.

The action of alcohol on furfural has also been tested *hypodermically* on one dog. Thus a certain dose of furfural alone in solution was given to this dog hypodermically. General muscular twitchings, particularly of face and head muscles, one severe convulsion (tonic and clonic) and another moderate convulsion occurred. Some days later *the same dose per kilo* of furfural was given together with 5 c. cs. of absolute alcohol for each gram of furfural. No convulsions or muscular twitchings occurred. The alcohol was in 60 per cent. solution.

Modifying action of amyl alcohol + ethyl acetate on furfural symptoms.

Amyl alcohol and Ethyl acetate have been *hypodermically* injected separately in combination with furfural, and some modification in the effect of the furfural has been observed. Only one experiment with each has been done as opportunity did not permit of pursuing this subject further.

Furfural + Amyl Alcohol.—A certain dose of furfural injected *hypodermically* in the case of a certain dog produced many convulsions (fourteen in number of which ten were *severe*). The same dose per kilo of furfural was later given to the same dog together with 1·04 gram of Amyl Alcohol (undiluted) for each gram of furfural given. Here there were only seven convulsions of which only two were *severe.* Possibly the *Amyl Alcohol* would have *prevented* the occurrence of convulsions had it been in solution. It is comparatively insoluble in water.

Furfural + Ethyl acetate.—A certain dose of furfural injected *hypodermically* in the case of a certain dog caused four (severe) convulsions. The same dose per kilo of furfural had been previously given *hypodermically* to the same dog together with 3·09 gram of ethyl acetate for each gram of furfural given and only two (severe) convulsions here occurred. Here again the ethyl acetate was undiluted and possibly more effect might have been produced had it been in solution.

But in all these cases where furfural was given *hypodermically,* together with ethyl alcohol, amyl alcohol or ethyl acetate, these substances acted as solvents for the furfural, or more or less extracted it from its watery solution.

In the case at least of amyl alcohol and ethyl acetate it might be argued that, owing to their relative insolubility and tissue destroying action, the furfural held by them in solution was very slowly absorbed. 60 per cent. alcohol might also be expected to cause coagulation and so lessen the rate of absorption of furfural. Consequently convulsions would not be so marked or likely to occur as when a solution of furfural in water was used.

The following experiment was done to ascertain the *rate of absorption of furfural by the stomach.* Weight of the animal to which dose was given=12·02 kilos.

12·5 c. c. of 8 per cent. solution furfural= *1 gram furfural.*

10·5 A.M.—Above dose given in 100 c. c. of distilled water by stomach-tube. Profuse salivation commenced quickly and continued throughout.

Rapidity of absorption of furfural from the stomach.

10·40.—Contents of stomach withdrawn, stomach washed out, and the washings mixed with above contents, and the mixture distilled for estimation of furfural.

(*Slight* swaying when the dog was standing was noticed just prior to withdrawal of stomach-contents, but no other signs beyond the salivation were observed.)

The liquor was then analysed and found to contain 0·18 per 1,000 of furfural, *i.e.,* about $\frac{4}{5}$ths of the dose was absorbed by the stomach.

The conclusion from the above is that furfural can be absorbed *well* by the stomach.

TABLE V.

ANIMAL EXPERIMENTS.

Furfural Residues.

Dog's weight, 11·11 kilos : amount of Residues given hypodermically=0·180 gram per kilo.

12-6 P.M.—Dose given hypodermically.

12-8 Salivating.

12-15 Salivating freely.

12-30 Still salivating : nothing further noticed.

Action of Furfural Residues.

Dog's weight 10·8 kilos : 3·2 grams residues given hypodermically=0·296 gram per kilo.

3-24 P.M.—Dose given hypodermically.

3-25—Salivating.

3-30—Salivating freely.

3-41—Spasmodic (clonic) movement of head : still salivating freely.

3-43—Spasmodic (clonic) movements of head frequently repeated.

3-49—Ditto occur on voluntary movement of head.

3-54—Seems normal except for salivation.

4-5—Ditto : eats freely.

These residues were obtained from various "pure" samples of furfural.

They boiled at much higher temperatures than furfural and differed markedly in physical characters. Time did not allow of any investigation as to their chemical composition.

TABLE VI.

HUMAN EXPERIMENTS.

Furfural alone—Solution in water freely diluted.

Absolute dose in grams.	No. of cases.	Noxious results.
0·0026	2	*Nil.*
0·026	2	*Nil.*
0·052	2	*Nil.*
0·078	3	*Nil.*
0·104	2	*Nil.*
0.162	3	*Nil.*
0·500	1	*Nil.*
0·550	1	*Nil.*
0·60	1	*Nil.*
0·650	1	*Nil.*
0·700	1	*Nil.*
0·75	1	*Nil.*
0·800	1	*Nil.*
0·850	1	*Nil.*
0·900	1	*Nil.*
0·950	2	*Nil.*

The above experiments thus shew that amounts varying from 0·0026 to 0·95 gram of furfural have been given in watery solution to men on 25 occasions without the occurrence of any noxious results.

ALDEHYDE EXPERIMENTS.

Human experiments with Aldehydes.

The subjoined table shows that in the 18 human experiments with acetaldehyde (the most commonly occurring member of the aldehyde group in spirits) it was given in doses varying from 0·065 gram to 2 grams. In three cases, very slight headache resulted and those in the case of small amounts, so that little importance can be attached to them except perhaps as instances of idiosyncrasy. 0·39 gram of aldehyde with one ounce of pure absolute alcohol (suitably diluted) was given to two men, with no noxious results.

One of us took 2 grams of acet-aldehyde *with 30 grams of pure absolute alcohol* (suitably diluted) and in 25 minutes had distinct headache (general sense of fulness with frontal headache) which lasted about 1½ hours. There were no after effects the next day. Another of us took 2 grams of acetaldehyde *alone* with no result whatever.

TABLE VII.

HUMAN EXPERIMENTS.

Acetaldehyde alone:—Solution in water freely diluted.

Actual dose in grams.	No. of cases.	Noxious results.
0·065	2	One had very slight (frontal) headache (after 5 hours).
0·130	2	*Nil.*
0·260	2	*Nil.*
0·390	3	Two had slight (frontal) headache.
0·600	1	*Nil.*
0·800	1	*Nil.*
1·000	1	*Nil.*
1·200	1	*Nil.*
1·400	1	*Nil.*
1·600	1	*Nil.*
1·800	1	*Nil.*
2·000	2	*Nil.*

Symptoms in dogs with large doses of Aldehydes.

With relatively large doses given to dogs great difficulty was experienced in obtaining exact comparative results. The irritating action of the aldehydes on the stomach or when injected subcutaneously is very considerable and causes vomiting or large sloughing wounds. We have, however, given aldehyde *by the mouth* in doses of 5 and 7 grams (0·39 and 0·56 gram per kilo); and the former amount was not vomited for half an hour, and yet in that time no symptoms developed. The latter dose was quickly vomited.

Acetaldehyde has also been administered hypodermically in doses of 0·275 to 0·63 gram per kilo (total doses of 3·5 to 7·0 grams) (see table) and is found to act in general somewhat like furfural (which is also an aldehyde). It rapidly produced convulsions (tonic and later clonic); and associated paralysis of voluntary muscles. In large doses, the (tonic) muscular spasms are very persistent and death occurs from paralysis of respiration. Here respiratory movements cease during the (tonic) convulsions for long intervals but *even when the general (tonic) muscular spasms are not present* the respiratory movements become very slow and shallow and finally cease.

Again, with a total dose of 7 grams (0·63 gram per kilo), in 2 minutes salivation occurred; the animal staggered about and died in four minutes.

TABLE VIII.

ANIMAL EXPERIMENTS.

Aldehyde given hypodermically.—Solution in water usually nearly 60 per cent.

Dose per kilo in grams.	Actual dose in grams.	Results.
0·275	3·5	In the first two experiments salivation and free watery secretion from nostrils occurred.
0 393	5·0	
0·380	6·17	In the third experiment the above symptoms and also slight loss of power in muscles.
0·500	5·5	Marked loss of power in muscles. Salivation.
0·503	6·6	Severe symptoms.
0·630	7·0	Very severe symptoms ending in death.

Probably there was a difference in absorption rates, owing to extreme irritant action. On this account and also owing to rapid loss of aldehyde from such a strong solution, these doses per kilo are somewhat high.

After administration there was marked general muscular paralysis. In a few minutes, general convulsions (tonic) followed, with head retracted, involuntary defœcation, and loss of sensation. The convulsions (tonic) became more frequent, severe and prolonged ; and, during the more severe, breathing ceased for about half a minute. Eight minutes after administration the pupils were widely dilated ;[*] the corneal reflex was lost; breathing became extremely slow and finally stopped whilst the heart continued to beat feebly till death occurred (12 minutes after administration).

With a smaller dose 0·503 gram per kilo (total dose, 6·6 grams) hypodermically death did not result. During the first 5 minutes—the same early muscular paralysis occurred with involuntary defœcation and micturition. The dog lay flat on its belly with limbs widely extended. Severe convulsions (tonic) occurred for the first five minutes and less severely for another five minutes. Within ten minutes from administration there were spasms and rigidity of various muscles; laboured, rapid breathing; some slight blueness of lips, etc. (cyanosis). Very irritable, bit at its chain, and snapped and barked on being touched. Pupils widely dilated. Some loss of sensibility. In 13 minutes from administration, it followed with its eyes any one moving about the room. (Involuntary defœcation continued at intervals.)

In 22 minutes it turned its head and wagged its tail when called. Lay normally and breathing was less laboured.

In 25 minutes it was able to stagger about but 2 minutes later fell over and had a (clonic) convulsion which was most marked in legs. Then walked slowly and with difficulty.

In about half an hour from administration it seemed to have recovered (compare with furfural where rapid recovery from even very severe symptoms is also found).

Results with smaller doses of Aldehydes.

In even smaller doses—0·275 to 0·5 gram per kilo: there occur salivation (sometimes profuse) ; free watery secretion from nostrils ; partial loss of power (paresis) in hind limbs with staggering gait ; involuntary defœcation and occasional twitchings of corner of mouth.

On account of the insuperable difficulties connected with administration by the mouth through the irritant effect produced, it has been found impossible to work out the minimal toxic dose of acetaldehyde.

Human experiments with other Aldehydes than Acetic.

The following statement shows the results of administration of aldehydes (other than acetaldehyde) to human beings.

TABLE IX.

HUMAN EXPERIMENTS.

Other less common Aldehydes.

Aldehydes.
Isobutyl aldehyde.
Amyl aldehyde.

10 per cent. solution in *60 per cent. alcohol* given well diluted with water Absolute dose 0·2 gram of each given to 2 cases. *Result, nil.*

Oenanthol : 10 per cent. solution in *70 per cent.* alcohol given well diluted with water.

Absolute dose 0·39 gram of each, given to 2 men. *Result, nil.*

ALCOHOL *PLUS* ALDEHYDE.

It was impossible to fully work out the action of relatively large doses given by the mouth as vomiting was quickly produced. The attached table shows the doses of aldehyde and alcohol given and the result.

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[*] Dilatation of the pupils from fear has always been allowed for. In this case the associated symptoms appear to exclude this cause.

TABLE X.

ANIMAL EXPERIMENTS.

Aldehyde+alcohol—Oral administration.

Effects compared with those of alcohol alone in the same dose per kilo. on pairs of dogs.

DOSE PER KILO IN GRAMS.	ACTUAL DOSE IN GRAMS.	RESULT.
Aldehyde+Alcohol	Aldehyde+Alcohol.	...
0·05+2·1	0·6885+28·917 ...	No difference.
0·05+2·1	0·669+28·098 ...	
0.08+2·1	1·2368+32·466 ...	No difference.
0·08+2·1	1·056+27·72 ...	
0·1+2·0	0·601+12·02 ...	Staggering gait slightly more marked.
0·1+2·0	0·606+12·2 ...	
1·12+2·0	1·578+26·3 ...	Ditto.
0·12+2·0	1·584+26·4 ...	
0·12+2·1	1·2648+22·134 ...	No difference.
0·12+2·1	1·476+25·83 ...	
0·15+2·1	2·031+28·434 ...	Staggering gait slightly more marked.
0·15+2·1	2·058+28·812 ...	
0·2+2·1	2·64+27·72 ...	Staggering gait.
0·2+2·1	3·084+32·382 ...	more marked.
0·3+1·8	3·129+18·774 ...	Staggering gait.
0·3+1·8	3·912+23·472 ...	more marked.

Results with Aldehyde plus Alcohol.

0·2 gram (per kilo) of aldehyde was given along with 2·1 gram (per kilo) of absolute alcohol to one dog; and to another alcohol in proportionate amount. This experiment was repeated. One of the dogs showed no enhanced effects from the aldehyde but the other did, being for a time paralysed and almost insensible instead of merely partially losing muscular power as in the case of alcohol alone.

To another pair of dogs on different occasions was given 0·15 gram per kilo of aldehyde: in the one case with 2·1 gram per kilo of pure alcohol and in the other alcohol alone; and then the experiments were "reversed" some days later. In each case, the dog that had been given the aldehyde was much more unsteady in its gait than the one which had had alcohol alone.

Again, with 0·1 and 0·12 gram (per kilo) of aldehyde added to alcohol (and proceeding as before) the dogs that had been given the aldehyde were slightly the more unsteady in gait. With 0·05 and 0·08 gram per kilo, however, no difference was appreciable between the dogs that had taken the aldehyde and those that had had only alcohol.

Conclusions as to noxiousness of Aldehydes.

The conclusions from the above experiments are that aldehyde, *in relatively large amounts*, increases the effects of alcohol and that it seems to do so chiefly by a *paralytic* action, as in the case of the furfural. The human experiments show that in the quantities ordinarily present (and even in amounts more than thrice as great as our analyses have ever shown to be present *per imperial quart of 60 U. P. liquor*) no noxious results followed. So that aldehyde, although in itself in sufficient doses a powerful poison, is practically negligible in the quantities found in potable liquors.

ACETALS.

Experiments with Acetal.

These are formed in alcoholic liquors by combination of aldehydes with alcohols. They have only been found in traces in spirits but *in wines* are stated to be important elements in the production of bouquet. They are readily decomposed in acid liquors so that they would not be likely to occur in the generally strongly acid native liquors. As the acetal corresponding to ethylic alcohol is believed to be that which predominates in potable liqours, half a gram up to 8 grams of it were *given in a 60 per cent. alcoholic solution* with no marked results.

TABLE XI.

ANIMAL EXPERIMENTS.

Acetal:—20 per cent. solution in 60 per cent. alcohol.

Dose per kilo in grams.	Actual dose in grams.	Results.
0·04 by mouth	0·5 ...	Salivation and paresis.
0·13 by mouth	1·5 ...	*Nil.*
0·31 hypodermically	4·0 ...	Salivation and seemed sleepy. (? if due to alcohol required for solution.)
0·6 hypodermically (40 per cent. in 60 per cent. alcohol)	8·0 ...	*Nil.*

PYROMUCIC ACID (ON DOGS).

0·09 (1·25 per cent) by month ...	1·25 ...	*Nil.*
0·3 (20 per cent. in 60 per cent. alcohol) hypodermically	4·0 ...	*Nil.*

And Pyromucic Acid.

Pyromucic Acid.—As this is the body into which furfural (pyromucic aldehyde) is converted by oxidation and as it has been supposed that furfural becomes changed to pyromucic acid to some extent in the system, the above experiments were done to ascertain if pyromucic acid was a physiologically active substance. 4 grams of it (in alcoholic solution) were given *hypodermically* on several occasions without noticeable effect; and, as this is a quite impossible amount to derive from the amount of furfural in any spirit, the conclusion is that the action of pyromucic acid as a possible toxic derivative of furfural is unimportant.

FUSEL OIL.

General effect of higher Alcohols.

Higher alcohols were found to produce (in dogs) *similar effects in general to those of ordinary (ethylic) alcohol but in greater degree,*—amyl having the greatest action; the butyl alcohols (iso-and normal) next; and the propyls (iso-and normal) least (see annexed tables).

Special action of Normal Propyl Alcohol.

Normal Propyl alcohol, however, we have observed to be specially noteworthy as generally producing repeated vomiting (usually bilious) about 20 minutes after administration. With isopropyl alcohol this special effect has not been observed. With the butyl alcohols, this tendency is also present but in a less degree.

Our experiments (see tables) show that these higher alcohols severally increase the intoxicating action of alcohol when administered along with it even in proportions which are relatively small as compared with the total amount of alcohol. For instance, 0·084 gram (per kilo) of amyl alochol when given with 1·8 gram (per kilo) of ethyl had a much greater intoxicating effect than 1·8 gram per kilo of ethyl alcohol alone.

Action of higher Alcohols compared quantitatively with Ethylic Alcohol.

Taking the most active of the higher alcohols first, *i.e.*, amyl, 0·2 gram per kilo would have about the same effect as 1·7 grams per kilo of ethyl alcohol (in 30 per cent. solution). That is to say, it takes more than eight times the amount of ethyl alcohol than of amyl to produce a like minimum effect, and in a solution more than ten times more concentrated. Certain previous observers have shown that when the comparison is made in the smallest amounts *necessary to kill,* 4 times the amount of ethyl alcohol than of amyl alcohol is required. For our purposes the minimal toxic dose given by the mouth was of more practical interest than

Minimal toxic dose of higher alcohols.

the minimal lethal dose. The minimal lethal doses were probably (almost certainly) determined by hypodermic injection. In fixing the minimal toxic dose we have resorted to the more practical method of administration by the mouth which necessitates giving the substances in solution.*

The following statement indicates generally our results as regards the relative toxicity of the chief higher Alcohols :—

—	Strength of solution in which given by mouth.	Minimal toxic dose in grams per kilo given by mouth.	Relative toxicity (Kasauli experiments.)	Relative toxicity according to Baer.
Ethyl Alcohol ...	30%	1·68	1	1
Propyl Alcohol (Iso- and normal separately) ...	10%	0·75†	2·3	2
Butyl Alcohol (Iso- and normal separately) ...	5%	0·45†	3·7	3
Amyl Alcohol ...	2·6%	0·20	8·3	4

AFTER EFFECTS WITH AMYL ALCOHOL.

After effects of Amyl Alcohol.

It has been found here that when an amount of amyl alcohol corresponding to that found *per litre* (*i.e.*, 1000 c. cs) in the worst liquors analysed, is added to *every 100 c. cs* of 30% alcohol *given to dogs* (and compared with a like amount per kilo of 30% pure alcohol), no special *after effects* were observed. Thus to one dog was given 35·425 grams of absolute alcohol (*i.e.*, 2·5 grams per kilo) along with 3·247 grams of amyl alcohol (*i.e.*, 0·228 gram per kilo) ; and to a second dog, at the same time, the same amount of absolute alcohol was given (in this case 31·725 grams). Although the dog that had been given amyl *plus* alcohol was more intoxicated in the ordinary sense no special *after effects* were observed.

The following table shows the *large doses of amyl alcohol which have been given without producing noxious results.* One of us also took 3 grams of amyl alcohol *along with 30 grams of absolute alcohol* with no noxious results.

TABLE XII.

HUMAN EXPERIMENTS.

AMYL ALCOHOL.—*Solution in water freely diluted.*

Actual dose in grams.	No. of men experimented on.	Noxious results.
1·0	2	*Nil.*
2·0	5	One had slight headache (after 5-6 hours.)
3·0	1	*Nil.*
4·0	1	*Nil.*
5·0	1	*Nil.*
5·5	1	*Nil.*
6·0	1	*Nil.*
6·5	1	*Nil.*

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* *Footnote.*—It is necessary in such observations to carefully take into consideration the strength of the solution in which the substance is administered as the intensity of action varies to some extent according to its concentration.

† The normal and iso varieties of Propyl and also of Butyl alcohols were separately examined, and it was found that the two varieties corresponded closely in action. They have therefore been in each case included under the heading " Butyl " or " Propyl " alcohol.

The following statement shows the results when higher alcohols *other than Amyl* were given to men :—

TABLE XIII.

HUMAN EXPERIMENTS.

Higher alcohols other than Amyl alcohol.

Normal Butyl Alcohol.—(Freely diluted with water to about 5%.)

		Noxious results.
Absolute dose—1 gram	2 cases	*Nil.*
,, 2 grams	4 cases	*Nil.*

Isobutyl Alcohol.—(Freely diluted with water to about 5%).

Absolute dose—2 grams	4 cases	*Nil.*

Normal Propyl Alcohol.—(Freely diluted with water to about 5%).

Absolute dose—2 grams	5 cases	One vomited. Two had "giddiness" after some 5 or 6 hours. Two had slight (frontal) headache for about two hours.

Isopropyl Alcohol.—(Freely diluted with water to about 5%).

Absolute dose—2 grams	4 cases	One had slight headache after 3 hours. One suffered from giddiness several hours later.

Octyl Alcohol.—(10% solution in 60% alcohol given well diluted with water).

Absolute dose—2 grams	2 cases	*Nil.*

The following series shows the gradual diminution of dose per kilo of higher alcohols until the minimum required to produce definite symptoms is reached :—

TABLE XIV.

ANIMAL EXPERIMENTS.

Amyl alcohol.—2·6% solution in water. Administered by mouth.

Dose per kilo in grams.	Actual dose in grams.	Results.
0·337	3·3	Very marked staggering gait. Visible pulsation of large arteries of neck (carotids). Paralysis. Loss of consciousness, with contracted pupils.
0·323	4·1	Ditto.
0·306	3·0	Very marked staggering gait. Paralysis. Diminished reflexes.
0·25	3·2	Very marked staggering gait. Diminished reflexes.
0·234	2·3	Ditto.
0·23	3·01	Marked staggering gait. Diminished reflexes.
0·228	2·84	Marked staggering gait. Diminished reflexes.
0·2269	2·88	Ditto.
0·2265	3·58	Slight staggering gait.
0·226	2·97	Ditto.
0·225	0·81	Ditto.

TABLE XV.

Animal Experiments.

Normal Butyl Alcohol.—5 % solution in water. Administered by mouth.

Dose per kilo in grams.	Absolute dose in grams.	Results.
0·700	6·26	Marked staggering gait.
0·530	6·05	Ditto.
0·500	6·63	Very slight swaying.
0·456	4·65	Very slight staggering gait.
0·453	7·19	Ditto.
0·450	7·0	Slight staggering gait.

TABLE XVI.

Animal Experiments.

Isobutyl Alcohol.—5 % solution in water. Administered by mouth.

Dose per kilo in grams.	Absolute dose in grams.	Result.
0·465	6·37	Marked staggering.
0·462	5·96	Slight staggering.
0·460	4·64	Slight swaying.
0·456	7·34	Nothing noticeable.
0·455	2·37	Slight staggering gait.

TABLE XVII.

Animal Experiments.

Normal Propyl Alcohol.—10 % solution in water. Administered by mouth.

Dose per kilo in grams.	Absolute dose in grams.	Result.
0·800	11·56	Very marked staggering.
0·796	9·21	Slight swaying.
0·750	10·52	Marked staggering.
0·740	8·89	*Nil.*
0·728	10·48	Slight unsteadiness.
0·720	9·63	Slight swaying.
0·710	10·46	Slight staggering.
0·520	1·90 (Pup)	Ditto.
0·510	6·08	*Nil.*
0·477	1·72 (Pup)	Slight staggering.
0·475	6·03	*Nil.*
0·461	6·07	*Nil.*

TABLE XVIII.

ANIMAL EXPERIMENTS.

Isopropyl Alcohol.—10 % solution in water. Administered by mouth.

Dose per kilo in grams.	Absolute dose in grams.	Result.
0·90	11·736	Slight staggering.
0·90	11·376	Ditto.
0·85	8·1	Ditto.
0·80	10·064	Ditto.
0·80	10·016	Slight swaying.
0·75	7·995	Ditto.
0·70	8·806	Slight staggering.
0·70	11·382	Slight swaying.
0·60	7·956	*Nil*
0·494	6·5	Slight swaying.
0·490	4·8	Ditto.
0·449	5·7	*Nil.*
0·393	5·0	*Nil.*
0·348	5·5	*Nil.*
0·3	3·8	*Nil.*

Enhancement effects of higher alcohols on ethylic alcohol.

The ensuing tables show the effects produced by administering the higher alcohols (Amyl ; Normal and Iso-Butyls and Propyls) along with pure alcohol (ethylic) with the view of bringing out any enhancement of effects.

TABLE XIX.

ANIMAL EXPERIMENTS.

Enhancing effect of higher alcohols on Ethyl alcohol.

Amyl Alcohol+Alcohol 30 %.—Effects compared with those of alcohol given alone in same dose per kilo, *i.e.*, 1·8 gram.

Dose per kilo in grams.	Actual dose in grams.	Resulting difference in pairs of dogs.
Amyl alcohol + Ethyl alcohol	Amyl alcohol + Ethyl alcohol	
0·084 + 1·8	1·333 + 28·566	Staggering gait increased in degree as compared with pure alcohol.
0·084 + 1·8	1·14 + 22·831	

Comparison of effects when amyl alcohol was given with a small dose of absolute (ethyl) alcohol and when amyl alcohol was given alone in the same dose per kilo, *i.e.*, 0·23 grams :

Dose per kilo in grams.	Actual dose in grams.	Resulting difference.
Ethyl alcohol + Amyl alcohol	Ethyl alcohol + Amyl alcohol	
(*a*) 0·229 + 0·23 ...	3·0 + 3·55 ...	No difference between the combination given and the amyl alcohol alone.
(*b*) 0·229 + 0·23 ...	3·12 + 3·13 ...	

TABLE XX.

ANIMAL EXPERIMENTS.

Alcohol+Normal Butyl Alcohol. Administration by mouth.—Effects compared with those of the same dose per kilo of alcohol alone, *i.e.*, 1·8 grams :

Dose per kilo in grams.	Absolute dose in grams.	Resulting difference.
Alcohol+Normal Butyl alcohol	Alcohol+Normal Butyl alcohol	
1·8 + 0·243	23·472 + 3·17	Staggering more marked with the combination.
1·8 + 0·243	23·472 + 3·17	

Normal Butyl Alcohol + Ethyl Alcohol. Administration by mouth.—Effects compared with those of the same dose per kilo of Normal Butyl alcohol, *i.e.*, 0·7 grams :

Dose per kilo in grams.	Absolute dose in grams.	Resulting difference.
Normal Butyl alcohol+Alcohol	Normal Butyl alcohol+Alcohol	
0·7 + 0·379	7·378 + 4·0...	Loss of consciousness (coma) with the combination. Marked staggering gait with the Normal Butyl alone.
0·7 + 0·69	5·796 + 4·0...	

Alcohol + Isobutyl Alcohol. Administration by mouth.—Effects compared with those of alcohol in the same dose per kilo alone *i.e.*, 1·8 grams :

Dose per kilo in grams.	Absolute dose in grams.	Resulting difference.
Alcohol+Isobutyl alcohol ...	Alcohol+Isobutyl alcohol	
1·8 + 0·188 ...	28·98 + 3·033 ...	Staggering gait much more marked in the case of the combination.
1·85 + 0·188 ...	26·85 + 26·085 ...	

Alcohol + Normal Propyl Alcohol. Administration by mouth.—Effects compared with those of the same dose per kilo of alcohol alone, *i.e.*, 1·7 grams :

Dose per kilo in grams.	Absolute dose in grams.	Resulting Difference.
Alcohol + Normal Propyl alcohol	Alcohol + Normal Propyl Alcohol	
1·7 + 0·319 ...	23·902 + 4·49 ...	Staggering more marked with the combination.
1·7 + 0·309 ...	24·48 + 4·449 ...	

Alcohol + Isopropyl alcohol. Administration by mouth.—Effects compared with those of the same dose per kilo of alcohol alone, *i.e.,* 1·85 grams.

Dose per kilo in grams.	Absolute dose in grams.	Resulting difference.
Alcohol + Isopropyl ...	Alcohol + Isopropyl ...	
1·85 + 0·433 ...	20·183 + 4·73 ...	Staggering much more marked with combined dose.
1·85 + 0·433 ...	16·983 + 3·98 ...	

Isopropyl Alcohol + Ethyl Alcohol. Administration by mouth.—Effects compared with those of the same dose per kilo of Isopropyl alcohol alone, *i.e.*, 0·9 grams :

Dose per kilo in grams.	Absolute dose in grams.	Resulting difference.
Isopropyl Alcohol + Ethyl alcohol	Isopropyl alcohol + Ethyl Alcohol	
0·9 + 0·233	11·565 + 3·0	*Nil.*
0·9 + 0·233	11·268 + 2·917	

ETHERS (COMPOUND ETHERS, ESTERS).

Results with ethers.

The following *human experiments* were conducted with the ethers below stated in order to ascertain whether they possessed any noxious properties when given in relatively large doses.

Ethyl, Isobutyl and Amyl Acetates were given together* freely diluted with water, in a dose of 1 gram of ethyl acetate with 0·5 gram of each of the other two, to four men with no noxious results.

Ethyl Butyrate, Isobutyl Butyrate, Ethyl Isobutyrate and Amyl Butyrate were given* together freely diluted with water, in a dose of 0·5 gram of each, to four men with no noxious results.

Ethyl and Amyl Valerianates were similarly given together* to four men in doses of one gram of each substance. In two cases, there was slight headache ; and in the other two no result.

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* These substances had to be made up in 10 per cent. alcoholic solution owing to their insolubility in water.

Ethyl Benzoate was given to four men in doses of two grams without any noxious result.

Ethyl Pelargonate and Ethyl Oenanthate were given* to four men in compound doses of one gram of each substance without noxious result.

Ethyl Acetate, which is the ether most largely present in alcoholic liquors was given in the relatively enormous dose of 7 grams (1·11 grams per kilo) to a very small dog with no noticeable result.

It was also given, well diluted with water, to two men in a dose of two grams without noxious result.

Ethyl acetate plus alcohol.

Ethyl acetate was then given along with pure alcohol to dogs in order to observe any additional effects when contrasted with a corresponding dose per kilo of pure alcohol. The effect of this ether became evident only when relatively enormous proportions of it (*viz.*, 0·5, 0·6 and 0·865 gram per kilo) were added to the amounts of alcohol given. With the two lesser amounts mentioned the difference was only slight.

With 0·1 gram per kilo of ethyl acetate added to the alcohol no additional effect was noticed; and with 0·4 and 0·45 gram per kilo no certain difference could be observed.

The following statement shows the proportions in which ethyl acetate has been given along with alcohol and the results:

TABLE XXI.

ANIMAL EXPERIMENTS.

Alcohol+Ethyl acetate.—Effects compared with those of the same dose per kilo of alcohol alone.

Dose per kilo in grams.	Absolute dose in grams.	Resulting difference.
Alcohol + Ethyl Acetate ...	Alcohol + Ethyl acetate	
2·2 + 0·1 ...	26·796 + 1·218 ...	*Nil.*
2·2 + 0·1 ...	35·046 + 1·593 ...	
2·2 + 0·4 ...	29·436 + 5·352 ...	*Nil.*
2·2 + 0·4 ..	34·782 + 6·324 ...	
2·5 + 0·45 ...	37·4 + 6·732 ...	Staggering gait somewhat more with the combined dose.
2·5 + 0·45 ...	30·75 + 5·575 ...	
2·1 + 0·5 ...	14·674 + 3·335 ...	Very slightly more staggering with combined dose.
2·1 + 0·5 ...	17·724 + 4·22 ...	
2·2 + 0·6 ...	47·63 + 12·996 ...	Staggering somewhat more marked with combined more dose but not much so.
2·2 + 0·6 ...	44·022 + 12·006 ...	
2·0 + 0·865 ...	23·12 + 10·0 ...	Staggering somewhat more marked with combined dose, but not much more so.
2·0 + 0·865 ...	26·76 + 11·573 ...	

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* In 10 % alcoholic solution.

After-effects of Ethers.—When an amount of Ethyl Acetate corresponding to that found *per litre* (*i.e.*, 1000 c.cs) in the worst liquor analysed is added to *every 100 c. cs* of 30 per cent. alcohol and is *given to dogs*, no special *after-effects* are observable. Thus to one dog was given 42·8 grams of absolute alcohol (*i e*, 2·5 grams per kilo) along with 6·419 grams of ethyl acetate *i.e.*, 0·37 gram per kilo), while at the same time a second dog received the same amount per kilo of absolute alcohol alone (in this case 33·9 grams). Although the dog that received alcohol *plus* ethyl acetate was more intoxicated no special *after-effects* were observed.

After effects of Ethers.

VOLATILE OILS.—Administration by the mouth, to animals: 10 c c.* of combined essences of coriander, and cardamom *i. e.*, 5 c. c. essence of coriander (1 in 10 of 90 per cent. alcohol by volume); + 5 c.c. essence of cardamom (1 in 10 of 90 per cent. alcohol by volume); given with an equal volume of water to a dog of 14·1 kilos. Result: *Nil.*

TABLE XXII.

ANIMAL EXPERIMENTS.

Alcohol + Oil of aniseed.—Effects compared with those of the same dose per kilo of alcohol alone.

Dose per kilo in grams.	Absolute dose in grams.	Resulting difference.
Alcohol + Oil of Aniseed ...	Alcohol + Oil of Aniseed.	
2·2 grams + 0·0023 c.c ...	44·762 grams + 0·05 c.c ...	*Nil.*
2·2 ,, + 0·0023 ,, ...	44·154 ,, + 0·04 ,, ...	
2·2 ,, + 0·1 ,, ...	26·554 ,, + 0·12 ,, ...	*Nil.*
2·2 ,, + 0·1 ,, ...	39·292 ,, + 0·17 ,, ...	
2·1 ,, + 0·018 ,, ...	28·812 ,, + 0·25 ,, ...	Staggering slightly more marked with combined dose.
2·1 ,, + 0·018 ,, ...	28·56 ,, + 0·25 ,, ...	
2·3 ,, + 0·02 ,, ...	32·982 ,, + 0·28 ,, ...	*Nil.*
2·3 ,, + 0·2 ,, ...	29·992 ,, + 0·26 ,, ...	
2·3 ,, + 0·05 ,, ...	49·128 ,, + 1·06 ,, ...	Staggering slightly more marked with combined dose.
2·3 ,, + 0·05 ,, ...	47·725 ,, + 1·03 ,, ...	
2·0 ,, + 0·53 ,, ...	29·58 ,, + 0·75 ,, ...	Staggering slightly more marked with combined dose.
2·0 ,, + 0·53 ,, ...	28·0 ,, + 0·75 ,, ...	

Effect of Volatile oils plus alcohol.—With progressive doses of certain volatile oils *plus* alcohol no difference in the gross effects was noted until the amount of added (anise) oil reached 0·05 c. c. per kilo. Then the difference between the dog that had been given the anise oil *plus* alcohol and that which had taken the alcohol alone was quite slight: in the former case, the gait was more staggering (ataxic).

The amount given (0·05 c.c. per kilo) was *more than could be held in solution in the alcohol of the strength used* (37 per cent. by volume), so that it will be seen that enhancement of effect from this cause would seem to be practically negligible.

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*c. c. = cubic centimetre.

HUMAN EXPERIMENTS WITH VARIOUS COMBINATIONS OF BY-PRODUCTS, WITH AND WITHOUT ALCOHOL.

The proportions of by-products approximate to, and in certain cases exceed, the amounts found in the worst samples of liquors analysed by us and are calculated as *grams per imperial quart of 60 U.P. strength.*

Results with furfural and aldehyde on men.

Furfural and aldehyde have been given together in the doses below mentioned in 6 cases; and in only one case a slight headache resulted. No after-effects resulted in any case next morning.

TABLE XXIII.

Human Experiments.

Furfural and Aldehyde :—Solution in water freely diluted.

Furfural		Aldehyde.		No. of cases.	Noxious result.
0·0026	+	0·065 gram	... ...	1	*Nil.*
0·078	+	0·13 „	... ...	1	*Nil.*
0·104	+	0·26 „	... ...	1	*Nil.*
0·162	+	0·39 „	... ...	3	One case had slight headache lasting about 1 hour.

Results with combined furfural, aldehyde and various higher alcohols when given to men.

Furfural and aldehyde together were next given in doses respectively of 0·162 and 0·39 gram in 22 cases to men in combination with two grams of each of the principal higher alcohols, as is shown in the following statement :—

Single doses (i.e., *non-continuous*).

Furfural + aldehyde + amyl alcohol in solution in water.		*Noxious result.*
0·162 + 0·39 + 2·0 grams	6 cases.	*Nil.*

Furfural + aldehyde + Normal Butyl alcohol. in solution in water.		*Noxious result.*
0·162 + 0·39 + 2·0 grams.	4 cases.	*Nil.*

Furfural + aldehyde + Isobutyl alcohol in solution in water.		*Noxious result.*
0·162 + 0·39 + 2·0 grams.	4 cases.	*Nil.*

By-products and absolute doses.

Furfural + aldehyde + Normal Propyl alcohol in solution in water.		*Noxious result*
0·162 + 0·39 + 2·0 grams.	4 cases.	Two had slight headache. One other had "giddiness" and the fourth vomited.

Furfural + aldehyde + Isopropyl alcohol.	Solution in water.	*Noxious result.*
0·162 + 0·39 + 2·0 grams.	4 cases.	One had headache after about two hours. When the same doses were given several days later to the same man there were no noxious results.

Furfural + Aldehyde + Amyl alcohol + Ethyl acetate in solution in water.		*Noxious Result.*
0·162 + 0·39 + 2·0 + 1·56	2 cases.	1 had a "sense of fulness in head"

In the case of the Amyl combination the 6 men who took it had no noxious symptoms.

Similarly with the 4 men who took the Normal Butyl, and the 4 who took the Isobutyl alcohol.

With the Normal Propyl combination all four cases suffered from various symptoms: two had slight headache, one vomited, and one had giddiness. It will be remembered that, in the experiments on dogs, Normal Propyl alcohol almost invariably produced vomiting.

With the Iso-propyl combination of the 4 cases one had headache after two hours. The same dose was again given several days later to the same man without any noxious results, so that the former result may be neglected.

In none of the above combinations were there any after effects on the following day.

In the cases of the five human experiments with Normal Propyl alcohol in 2 gram doses it may be noted that in every case slight noxious symptoms resulted.

Propyl alcohols' preponderance in fusel of patent-still spirits.

It is of interest to bear in mind with reference to the allegations that have been made regarding the comparative deleteriousness of patent-still spirits as compared with matured pot-still spirits that the Propyl (Normal and Iso) alcohols are those that particularly occur in patent-still spirits.†

Single by-products with alcohol given to men.

The following statement shows the result obtained in the few cases specified with the combinations:—

TABLE XXV.

HUMAN EXPERIMENTS.

Single doses of alcohol and a by-product.

		NOXIOUS RESULT.
Pure Alcohol 30 grams + Furfural 0·95 gram (made up to 150 c. c. with water)	1 case*	*Nil.*
Pure Alcohol 30 grams + Aldehyde 2·0 grams (made up to 150 c. c. with water)	1 case*	Distinct though not severe headache.
Pure Alcohol 30 grams + Amyl Alcohol 3·0 grams (made up to 150 c. c. with water)	1 case*	*Nil.*
Pure Alcohol 30 grams + Ethyl acetate 3·7 grams (made up to 150 c. c. with water)	1 case*	*Nil.*
Pure Alcohol 30 grams + oil of Anise 6 drops	1 case*	*Nil.*
Pure Alcohol one ounce + Aldehyde 0·39 gram (made up to 150 c. c. with water)	3 cases*	2 cases *Nil.* 1 had very slight * headache.
Pure Alcohol one ounce + Aldehyde 0·39 gram + Isopropyl alcohol 2 grams (made up to 150 c. c. with water)	1 case*	*Nil.*
Pure alcohol one ounce + 0·162 gram Furfural	1 case*	Slight headache.
Pure alcohol one ounce + 1·7 gram Amyl alcohol	1 case*	*Nil.*
Pure alcohol 1 ounce; Furfural 0·162 gram; Aldehyde 0·39 gram; Amyl Alcohol 1·7 gram; Ethyl acetate 1·56 gram	1 case*	Slight headache.

* *Same man.*—In this man it will be noted that no headache occurred after the single dose of amyl alcohol or of ethyl acetate (in each case given along *with pure alcohol*). In the case of the 2 experiments with furfural *plus* alcohol headache occurred at once. In the two aldehyde *plus* alcohol experiments, headache occurred both times. With the combination of these four chief by-products with alcohol, headache also resulted.

This man also took *without alcohol* (*a*) 0·078 gram and 0·162 gram of furfural in single doses without result;

(*b*) 0·39 gram acetic aldehyde in single dose with slight headache;
(*c*) *in combination* 0·162 gram of furfural and 0·39 gram acetaldehyde with slight headache;
For ten consecutive days he took combined
(*d*) Aldehyde 0·55 gram
Furfural 0·10 gram
Amyl alcohol for 6 days 1·8 grams
Propyl „ substituted for amyl for following 4 days in 1·8 grams dose.
Acetic ether, 4·0 grams.
With no noxious results.
Also (*e*) for 14 consecutive days the following combination:—
Furfural 0·1 gram
Aldehyde 0·13 gram
Amyl alcohol 0·9 gram
Ethyl acetate 1·0 „
Headache resulted on 3rd and 8th day.
(*f*) On a single occasion the following combination was taken without any noxious effects:
Furfural 0·162 gram.
Aldehyde 0·39 „
Amyl alcohol 1·70 gram.
Ethyl acetate 1·56 „

† See evidence given by Dr. Bell, C.B., F.R.S., before Lord Playfair's Commission on spirits (Questions 3627 to 3531).

Combinations of chief by-products in large amounts without alcohol given to men.

Combinations of the Chief By-products administered without alcohol.—These amounts corresponded to "medium," "high" and "maximum" proportions of the by-products found by us on analysis. The combinations were daily administered for 10, 14 and 15 days to five men with the results noted which can only be regarded as trivial when the combination of such large proportions of by-products is taken into account,—*a combination of maximal amounts of each by-product which has never been found on analysis.*

TABLE XXVI.

HUMAN EXPERIMENTS.

Continuous daily administration.

COMBINED "MEDIUM" PROPORTIONS OF PRINCIPAL BY-PRODUCTS.

Furfural 0·1 gram ... ...
Aldehyde 0·13 gram ... ...
Amyl Alcohol 0·9 gram ... ...
Ethyl Acetate 1·0 „ ... ...
} Made up to 150 c. c. with water.

For 14 days to one subject.

Results: General headache on 3rd and 8th days.

COMBINED "HIGH" PROPORTIONS OF PRINCIPAL BY-PRODUCTS.

Furfural 0·162 gram ... ...
Aldehyde 0·39 „ ... ...
Amyl Alcohol 1·7 gram ... .
Ethyl Acetate 1·56 gram ... ...
} Made up to 150 c. c. with water.

For 15 days to two subjects.

Results:—One had very slight headache for one hour on the 8th day.

THE SAME COMBINATIONS OF BY-PRODUCTS GIVEN ALONG WITH ALCOHOL.

Combinations of chief by-products in large amounts along with alcohol given to men.

The "medium" proportions of by-products were given to one man for 14 days, along with 1 ounce of alcohol once daily, with no noxious results.

The same combination was given to two men but with two ounces of alcohol (instead of one as previously) for 14 days. In one case there were no after effects at any time. In the other, slight headache ensued on the evening of the first day; and on the second evening bad headache which disappeared during dinner. On the third day, slight fever occurred (? if related) in the evening but had disappeared by the following morning. He had on the eighth and ninth morning no appetite; and on the 10th day suffered from headache in the afternoon for several hours. Nothing further was noticed.

TABLE XXVII

HUMAN EXPERIMENTS.

Continuous Daily Administration.

ALCOHOL + BY-PRODUCTS.

Pure absolute* alcohol 2 ounces ... ...
Furfural 0·1 gram ... ...
Aldehyde 0·13 gram ... ...
Amyl Alcohol 0·9 gram ... ...
Ethyl acetate 1·0 gram ... ...

} "*Medium*" *proportions* of by-products. Total made up to 150 c. c. with water.

Two subjects for 14 days.—See below for *Result.*

Given to one subject with one ounce of alcohol for 14 days. Noxious Result, Nil.

Pure absolute alcohol* two ounces ... ...
Furfural 0·162 gram ... ...
Aldehyde 0·39 gram ... ...
Amyl alcohol 1·7 grams ... ...
Ethyl acetate 1·56 grams ... ...

} "*High*" *proportions of by-products.* Total made up to 150 c. c. with water.

To one subject for 4 days ... ...
To another for 9 days ... ...
To another for 13 days ... ...

} For *Result* see below.

Pure absolute alcohol *two ounces (*twice in the day, i.e.,* 2 ounces in morning with by-products and 2 ounces in the afternoon without by-products).
Furfural 0·162 gram ... ...
Aldehyde 0·39 " ... ...
Amyl alcohol 1·7 grams ... ...
Ethyl acetate 1·56 grams ... ...

} "*Maximum*" *proportions of By-products.* Total made up to 150 c. c. with water.

To two subjects for 3 days. Noxious Result, Nil.

The above statement shows that relatively very large proportions of the chief by-products were given daily, along with 2 ounces of pure alcohol :

(*a*) to one man for 13 days ;
(*b*) to another for 9 days ; and
(*c*) to another for 4 days.

(*a*) had slight headache on the evening of the 10th and 11th days.

(*b*) had slight headache at noon on the 9th day for about an hour.

(*c*) had moderate headache on the evening of the first day and slight head-ache on the afternoon of the 2nd day.

To two other men for 3 days exactly the same combination was given in the morning ; and in the afternoon two additional ounces of pure (absolute) alcohol suitably diluted. No noxious results ensued.

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* A certain amount of a definite percentage solution of pure alcohol in water equivalent to two ounces of absolute alcohol was taken ; the by-products were added ; and the total amount made up to 150 c. c. with water.

In none of the above were there any after-effects on the following day.

Finally, two of us have taken daily for ten days the following proportions of by-products which will be seen to exceed the largest amounts found on analysis

TABLE XXVIII.

HUMAN EXPERIMENTS.

Combined by-products in maximal amounts.—Continuous administration.

Comparison of by-products, (maxima found on analysis) administered in combination to men.

By-products.	Maximum amounts found on analysis in spirits (grams per impl. quart).	Amounts in grams taken by two of us daily for 10 days.
Acetic Aldehyde	0·534	0·55
Furfural	0·093	0·10
Amyl Alcohol for 6 days	1·692 ("fusel oil") as amyl.	1·80
(Propyl substituted for following 4 days*)	...	1·80
Acetic Ether	3·930	4·00

* Propyl was substituted for amyl in view of the special symptoms previously observed in men and animals.

One of us took this total amount (that is, 6·45 grams of these four by-products) alone; and the other took this dose along with one ounce of pure alcohol. It must be remembered that these amounts of each of the by-products have never been found combined in any of the liquors analysed by us. So that the severity of the test will be evident.† The results were as follows :—

In both cases, slight feeling of discomfort in the head, not amounting to pain, was experienced for about two hours after each dose. No after-effects the next day.

PURE (ETHYL) ALCOHOL.

Comparative results obtained with pure (ethylic) alcohol when given to men.

The following experiments were conducted with the object :

(1) of eliciting the reaction (as regards noxious results) of healthy men to pure alcohol which had been deprived of all by-products.

(2) and also of comparing the action of pure alcohol with pure alcohol to which various by-products, singly or in combination, had been added in known amounts.

HUMAN EXPERIMENTS.

Pure alcohol alone suitably diluted has been administered to men in doses of one and two ounces (*i.e.*, of "absolute alcohol") as follows :—

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† The addition of marked amounts of acetic acid to the above mixture made no difference whatever.

Non-continuous experiments.—Pure alcohol in single doses of one ounce daily was given to five men with no noxious results.

In single doses of two ounces it was given to four men and the only noxious results noticed were that two had slight headache after a few hours. The other two had no noxious symptoms. No after-effects next day occurred in any of these cases.

Three men were given doses of two ounces in the morning and two ounces in the afternoon. Two vomited about three hours after the second dose and that evening had lessened appetite. The third had headache lasting till the following morning as well as the above symptoms.

Continuous experiments with pure alcohol on men.

Continuous experiments.—When pure alcohol was given in single doses of two ounces daily for a fortnight to two men, in one case slight headache resulted on the 6th, 7th, 8th, 9th and 11th days; and bad headache on the 13th and 14th days. In the other case, nothing was noticed till the 14th day when headache was complained of.

In the case of two men who took two ounces in the morning and another two ounces in the afternoon for 9 days :—

(*a*) One case had, on the first day, very slight headache for about five hours in the evening; on the second day, severe headache for 5 to 6 hours in the evening, with slight headache next morning. Appetite not affected.

(*b*) The other case had slight headache on the first day for about 5 hours in the late afternoon and evening but nothing further.

Minimal toxic dose of pure (ethylic) alcohol.

The minimal toxic dose for dogs of pure alcohol was found to be 1·68 gram per kilo.

The following series represents the gradual diminution of the dosage per kilo until the minimum required to produce definite symptoms is reached.

TABLE XXIX.

ANIMAL EXPERIMENTS.

Pure Ethyl Alcohol.—30 per cent. weight per volume.

Dose per kilo in grams.	Absolute dose in grams.	Result.
3·0	44·04	Very marked staggering; temporary paralysis.
2·55	28·94	Ditto. ditto ditto
2·08	37·065	Very marked staggering.
2·0	30·6	Very marked staggering; temporary paralysis.
2·0	25·5	Very marked staggering.
1·9	10·868	Ditto ditto
1·8	26·208	Marked staggering.
1·69	16·849	Slight do.
1·68	24·896	Do. do.

Experiments with reputedly noxious country liquors.

Country Liquors reputed to be particularly noxious were compared *on dogs* with pure alcohol and in some cases with pure alcohol *plus* the amounts of by-products found in the country liquor samples in question. All these were made up to a uniform alcoholic strength of 30 per cent,* and, of course, in all comparative experiments the animals were given the same dose of alcohol per kilo.

Samples of Rawalpindi perfumed liquor; of some weak out-still liquors from Bengal; of "Bungla," "Phul" and of "Dzu" were examined with the result that "Phul" alone appeared to have a somewhat greater intoxicating effect *on dogs* than the alcohol alone. The enquiry was not pursued as dogs cannot show minor differences in effects.

The action of the acids present in spirits is already well understood and it will be sufficient to add that they appear to have little if any modifying influence on that of the other by-products.

NOTE.—The disproof of a suggestion made by Sir Lauder Brunton (Evidence before Lord Playfair's Commission on British and Foreign Spirits, Question 3844) as to the causation of the dryness of mouth and of the thirst following the use of alcohol has incidentally been arrived at in the course of our experiments. Sir Lauder Brunton suggested that the mouth-dryness might be due to the action of an alkaloidal substance resembling atropine (the active principle of belladonna and which causes marked dryness of the mouth and thirst), as certain observers had found small amounts of volatile alkaloids in certain spirits—chiefly those made from beets. I have already pointed out that in no instance have I detected any trace of such alkaloidal bases in the course of my special search for them in the very various types of spirits examined.

Causation of certain symptoms associated with alcoholic indulgence.

Again, when experimenting with alcohol freed from all by-products and also certainly containing no trace of such volatile bases as those to which Brunton referred, I find that these late symptoms or "after-effects" of alcohol are markedly produced. The explanation seems to be that the dryness of mouth is due to the comparatively late effects of the alcohol in inducing a lowering of activity (paresis) of the nerves controlling the production of saliva by the salivary glands and of the other glands present in the lining membranes of the mouth and throat. It certainly could not be due in such cases to any known by-product of alcohol for these were proved by searching analyses to be entirely absent from the pure alcohol used in my experiments. In the case of free alcoholic indulgence some part of this action may also be due to the digestive disturbance which so often ensues.

By the above it is not meant to show that these special symptoms are produced *only* by pure alcohol, as similar effects have been noted by us after taking *large* quantities of the chief by-products *alone*.

My object is only to show that the effect is not necessarily associated with the presence of any alkaloidal substances in alcoholic liquors.

SUMMARY OF PHYSIOLOGICAL SECTION.

Result of Local Enquiries as to prevalent drinking habits and quality of liquors in use in India.

Summary of local officers' replies.

Amounts of liquor consumed.

One of the most useful facts that has been brought out by the answers of local officers is that concerning the average daily quantities of spirits and fermented liquors consumed in India, *viz.*, ¼ to ½ a "bottle" (say, 6 to 12 ounces) of spirits of various strengths; and under two "bottles" (say, 50 ounces) of fermented liquor. Spirits are generally consumed in the evening after the day's work is over; and fermented liquors at intervals throughout the day as a rule.

Answers as to particularly noxious liquors.

Country spirits are usually taken undiluted; while imported liquors are in most cases diluted before consumption. No particular liquor (apart from quantity and alcoholic strength) was found:

(*a*) to specially incapacitate the consumer from resuming work next day;

(*b*) to speedily produce helpless intoxication in small amounts;

(*c*) to be specially slowly recovered from;

(*d*) to have particularly noticeable after-effects;

---

* The by-products were made up to their original proportions (in grams per litre) after the adjustment to 30 per cent.

(*e*) to be connected with apparently purposeless outbursts or crimes;

(*f*) to have any special effect in producing maniacal or other exceptional mental states (except perhaps "tari" which has gone bad through having been kept too long);

(*g*) to produce any unusual conditions referable to any particular set of bodily functions;

(*h*) to produce alcoholic neuritis; or

(*i*) diseases which foreign liquors do not induce when taken for long in excess.

Drugging of liquors.

The question as to drugging liquors elicited some comparatively unimportant additional information as to local practices in this respect.

Local Preference.

The stated preferences of natives in various parts of India for any special type of liquor added little to what was already well known on the subject, as did the answers to the questions concerning increased indulgence at private and religious festivals; and on the relative effects of fermented and distilled liquors.

General results.

On the whole, the information given is either of a confirmatory or negative value.

The action of ordinary (Ethylic) alcohol has been briefly described.

WITH REGARD TO THE EXTENT TO WHICH MY RESULTS SUPPORT THOSE OF OTHER OBSERVERS:

Confirmation of results of enquiry by previous observers.
Furst.

(1) The symptomatic effects of fusel oil described by Furst have been confirmed, as have also in general the results obtained by Richardson.

Rabuteau.

(2) Rabuteau's statement that the by-products rather than ethylic alcohol were the specially noxious factors in alcoholic liquors is not borne out by our experiments.

Beaumetz and Audije.

(3) As regards Dujardin-Beaumetz's and Audijé's results, in general I agree that the higher alcohols, aldehydes and ethers will in sufficient amounts increase the effects of alcohol but I consider that in the *comparatively small proportions* in which these by-products are present in potable liquors the effect is too small to be noxious or of any practical importance. As regards their belief " that the poisonous effects of spirit-drinking are due to the slow accumulation in the system of the by-products," attention can only be drawn to our experiments continued for 10 to 15 days in which larger amounts of by-products have been taken (with and without alcohol) than have been found by us to occur *per imperial quart* in any liquor and without any noxious results.

Brockhaus.

(4) My conclusions accord with Brockhaus's that the by-products of spirits are more potent than ethylic alcohol. This, however, must be taken to refer to the comparison of *equal quantities of by-products and of alcohol* and these proportions are, of course, never remotely approached in practice. With regard to his conclusion that the by-products of spirits "play an essential part in the development of diseases due to drinking" it will be remembered that the experiments here have not been undertaken with a view to proving or disproving this thesis, as to do so would have involved a very lengthy pathological investigation which was outside the scope of the present enquiry. With regard to Brockhaus's remarks concerning aldehyde it has been shown that in the doses and dilutions of aldehyde administered here to men no markedly irritant action

has been observed but that when given *in large amounts to animals* symptoms of extreme irritation of mucous membranes and of the nervous system undoubtedly result.

French Commission, 1886.

(5) With regard to the conclusion of the French Commission in 1886 that the higher alcohols were the injurious ingredients of certain spirits, although I recognise that the higher alcohols act similarly to but in greater degree than ethylic alcohol, yet in the amounts in which they have been found in spirits they can scarcely be regarded as " injurious ingredients."

Boutigny, etc.

(6) With regard to the observations of Boutigny, Poggiale, Lussanna and Albertoni concerning the injurious effects of acetic aldehyde our experiments amply show that such action does result *in sufficiently large doses;* but, with regard to the two latter observers' statement as to the "intoxicating" effect of aldehyde I agree that it is undoubtedly powerfully toxic though not in the ordinary sense "intoxicating."

Husz.

(7) With regard to Husz and Dahlström's work, experiments have not been conducted here on animals for the periods or on the lines followed by them.

In Husz's *human* experiments the amounts given of "fusel oil" would appear to have been administered undiluted as I find that much larger amounts in solution, adequately diluted, have had on the whole no such noxious effects as described by him. I quite agree with Husz's conclusions that the amounts of fusel oil in spirits are too small to cause the symptoms of alcoholism though they may probably slightly enhance them.

(8) Our comparative experiments *on dogs* with

(*a*) Country spirits;

(*b*) with pure alcohol containing similar amounts of by-products to those found in (*a*); and

(*c*) with pure alcohol alone—the alcohol (absolute) being given in the same doses per kilo of body weight in (*a*), (*b*), and (*c*) and in the same dilution,—bear out Stenberg's conclusion that "raw or purified spirits had the same kind and intensity of intoxicating action" *i.e.*, as far as experiments on *animals can* show such.

Stenberg.

Strassmann.

(9) I am in agreement (from the result of my experiments on dogs) with Strassmann's conclusion that 3 per cent. of amyl alcohol increases the symptoms of alcoholism in dogs. With regard to the reduction of the fatal period by half our experiments have not been carried out with the view of eliciting such facts. His conclusion " that neither clinical experience nor experiments on animals have ever proved that a spirit containing 300 to 500 milligrams* of higher alcohols per 100 c. cs. alcohol has a *worse* effect than the same amount of a pure spirit" is in complete accordance with the views I have formed as the results of the experimental work done here.

Allen.

(10) I have confirmed Allen's experiments on himself with fusel oil.

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* This is about the highest range in spirits found by us on analysis.

Brunton and Tunnicliffe.

(11) Our experiments with furfural on animals have given somewhat similar results to those obtained by Brunton and Tunnicliffe. It may be noted that its action (even after hypodermic injection in the doses I have employed) though very rapid can scarcely be termed "immediate," and that blueness of the tongue and lips has not generally been observed in spite of the marked respiratory embarrassment produced. Minimal lethal doses were not ascertained by me for the reasons previously stated.

In our 25 human experiments with furfural the "neuralgic pain and sense of pulsation in the vessels of the head" with ensuing "dull headache" (which occured in the two human experiments they mention) did not occur, although we gave more than *nine times the amount* given by them. It may be added that the furfural was given by us freely diluted as it occurs in liquors. (There is no mention of the mode of administration in their two human experiments).

We have not been able to confirm their observations as to the after effects on dogs (" restlessness ", " remarkably uncomfortable," " bad temper " and refusal of food) produced when aldehydes *plus* alcohol are given as contrasted with those produced by alcohol alone. The doses of aldehydes given by them are not stated. But we have found that when an amount of aldehyde corresponding to that found *per litre* in the worst liquors analysed is added to every *100 c.c. of 30 per cent. alcohol* given no such special after-effects were found. Thus to one dog was given 42·3 grams of absolute alcohol (*i.e.*, 3 grams per kilo) along with 0·7755 gram of aldehyde (*i.e.*, 0·055 gram per kilo). To a second dog at the same time the same amount per kilo of absolute alcohol alone was given (in this case, 41·16 grams). No difference in after-effects was observed.

On another day, the dog that had been given alcohol *plus* aldehyde was given alcohol alone and to the other dog was administered a proportionate dose of aldehyde *plus* alcohol. Again no difference in after-effects was observed. The loss of appetite mentioned by Brunton and Tunnicliffe has been noted irrespective of whether alcohol alone or along with by-products had been given. " Restlessness " has also been noted in some cases independently of the presence or not of by-products in the alcohol given.

Fine tremors have been specially observed as after-effects when other than quite small doses of furfural (which is an aldehyde), with or without alcohol, have been given to dogs. *On one occasion only* when furfural was given in a dose of 0·25 gram per kilo, to a medium-sized dog, it was noticed that as soon as the usual rapid recovery from the acute symptoms had occurred the animal showed marked irritability by growling and barking. The dog took its food readily when offered to it some two hours after recovery. Irritability *during the course* of the symptoms produced by 0·503 gram per kilo of acetaldehyde was also noticed on another occasion.

There seems no doubt that if aldehydes are given *in large doses* with alcohol the after-effects will be more severe than with alcohol alone. But the *practical* significance of such comparative effects when *large* doses are given is questionable as being too far removed from what occurs in actual practice.

With their remarks regarding " fusel oil " in potable liquors I am in entire accord.

With regard to their statements: " the fact that different kinds of alcoholic drinks produce when freely imbibed different mental states—gay, sad, maudlin,—also points to the conclusion that it is probably the by-products contained in spirituous drinks rather than the ethylic alcohol itself which give the special timbre to the mentation of the drinker or drunkard " and also that violent purposeless crimes committed under the influence of " impure spirits " are due to a similar cause, I may make the following observation.

It would seem that the different mental states produced depend at least equally (possibly even more) on the individual's reaction to alcohol and on the amount and strength of the liquor consumed.

Friedenwald.

(12) From the record of Friedenwald's experiments, which have (like Dujardin-Beaumetz's) extended over a period of several years, it will be sufficiently evident what length of time is required to add even so few facts to the knowledge of the subject from a pathological point of view. It will be remembered that the investigation here has not been conducted on pathological or purely physiological lines for the reasons previously stated.

CONCLUSIONS DRAWN FROM THE PRESENT ENQUIRY.

Total number of expriments performed.

In all, about 670 animal experiments* and 350 human experiments have been done, a total of over 1,000.

FURFURAL.

Furfural's action on animals.

As regards *the animal experiments*, it was found that alcohol exerts a certain amount of antidotal action on furfural as regards its convulsant action when *small* doses of alcohol are given with *relatively large* doses of furfural. On the other hand certain amounts of furfural when given with large doses of alcohol were shown to add to the alcohol's action and that apparently chiefly by the paralysing action of the furfural. The additional effect of furfural on alcohol was, however, not observed till the amount of furfural given *per kilo of body weight* (along with alcohol) exceeded the *absolute amount of* furfural that would be consumed in an imperial quart of 60 U. P. liquor containing the maximum amount of furfural ever found by us.

Human Experiments with Furfural.

And on men.

Far more important from the *practical* stand-point were the results obtained on human subjects. Doses of furfural far greater than any ever found by us in potable liquors (per imperial quart of 60 U. P.) were administered in single doses and continuously for several consecutive days to men without noxious results. Even when more than these maximal amounts of furfural were taken along with more than maximal amounts of the other chief by-products (with and without alcohol) for several consecutive days by different men no noxious results occurred.

ALDEHYDES.

Aldehydes' action on men.

The conclusion arrived at is that in relatively *large* amounts (such as are never known to occur in potable liquors *per imperial quart* of 60 U. P.) aldehyde adds to the action of alcohol, chiefly (as with furfural) by its paralysing effect.

The human experiments indicate that amounts thrice as great as are ever to be found in liquors, *per imperial quart of 60 U. P. strength*, can be taken by many, possibly by most, people without noxious results. Much less, then, would the amount of aldehyde taken daily by the average consumer in India have any noxious effects, for it must be borne in mind :—

(*a*) that the average amount of spirit consumed is ¼ to ½ a reputed quart which represents 6 to 12 ounces of liquor as against the 40 ounces of the imperial quart;

(*b*) that these amounts per imperial quart (or multiples thereof) were taken in our experiments *in a single dose* instead of being spread over the longer or shorter period required for the consumption of the corresponding quantity of liquor.

The same remarks, of course, must be borne in mind with reference to the other by-products and their combinations.

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* These numbers refer to actual administrations of substances for experiment and include "failures" from vomiting, etc.

Acetal and pyromucic acid.

Acetal and Pyromucic acid have been given to dogs in relatively very large doses without any apparent effects.

THE HIGHER ALCOHOLS.

Higher alcohols.

The higher alcohols.—(chiefly constituting the so-called "fusel oil") were found to have an enhancing effect on pure alcohol—*qualitatively* the same as the latter's action but *quantitatively* greater.

Normal propyl alcohol was specially observed to produce repeated bilious vomiting.

Quantities of the various higher alcohols greater than have ever been found *per imperial quart* in potable spirits have been given, with and without alcohol, to men—in single doses and also for several consecutive days—on the whole without any noxious results.

ETHERS.

No noxious results were obtained with the ethers* administered to men. No additional effect was produced with ethyl acetate (the ether most largely present in alcoholic liquors) when given with alcohol to dogs, except in relatively enormous doses and even then the differences produced were quite trivial.

Ethers.

Volatile oils.

Volatile Oils.—Negative results were obtained on dogs with the volatile oils ordinarily added to spirits when given in large amounts. It was not until an amount was added to alcohol which it could not hold in solution that any enhanced result occurred and even then the difference was very trifling.

ALCOHOL ALONE AND WITH BY-PRODUCTS.

CONTRAST OF ACTION OF ALCOHOL ALONE AND *PLUS* BY-PRODUCTS.

Contrast of action of alcohol alone and *plus* by-products.

The comparative effects as regards noxiousness of pure alcohol, alone and when combined with large proportions of its by-products, may here be contrasted side by side†:—

TABLE XXX.

HUMAN EXPERIMENTS.

PURE ALCOHOL ALONE.	PURE ALCOHOL PLUS BY-PRODUCTS.
(One ounce of pure absolute alcohol once in the day). I. Cases, 5. Symptoms, Nil.	(One ounce of absolute alcohol once in the day). Cases 25. Symptoms: in 5 cases slight headaches.
II. Pure absolute alcohol alone, 2 ounces once in the day Cases 32. Symptoms in 9 *namely* Slight headache in 7 Severe „ in 2	Pure absolute alcohol, 2 ounces *plus* by-products once in the day. Cases 54. Symptoms in 8 *namely* Slight headache in 7 Severe „ in 1
III. Pure absolute alcohol alone, 2 ounces, *twice* in the day. Cases 21. Symptoms in 6 *namely.* Slight headache in 2 Bad headache in 2 Vomiting in 2	Pure absolute alcohol, 2 ounces. *plus* by-products once in the morning and 2 ounces of alcohol alone in the afternoon. Cases 6. Symptoms, nil.

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* Except slight headaches in 2 out of 4 cases with ethyl and amyl valerianates (1 gram of each), amounts of these substances far exceeding those ever present in liquor.

† The limited opportunities for conducting human experiments prevent the numbers from being as large as I could have wished and as are necessary for satisfactory statistical deductions.

According to this Table:

(*a*) Pure alcohol *alone* gave noxious results in 14 out of 58 cases (24 per cent.);

(*b*) Pure alcohol *with by-products* gave noxious results in 13 out of 85 cases (15 per cent.).

It would thus appear that alcohol *alone* is at least as deleterious as alcohol *plus* by-products. It might indeed be argued from these figures that alcohol *alone* is more deleterious: in other words, that these moderate amounts of by-products are actually beneficial in so far as they appear to favourably modify the action of the alcohol. I am, however, by no means prepared to draw any such conclusion in view of the limited number of human experiments made. I do, however, consider that the above results show that the difference in effects between alcohol with and without by-products is of no practical importance.

It is at first sight difficult to reconcile this conclusion with the admitted difference in action between, for example, raw and matured whiskeys. The usual explanation offered is the lessening *in amount* by age of the by-products (aldehydes, fusel oil, etc.) of such spirits. The chemical evidence as regards this has been shown in chapter XIII to be very vague and is too conflicting to oppose to the above positive evidence that such small quantitative differences are of no practical importance. My conclusion is also not in conflict with two other possible explanations of the effects of maturation, *viz.*, (*a*) *qualitative* changes resulting from the interaction of the recognised groups of by-products; and (*b*) the existence (and gradual modification or disappearance with age) of totally different classes of by-products, *e.g.*, the so-called pyro-compounds and creosotic bodies derived from the special fuel employed in malting the grain used in pot-still whiskey manufacture in the United Kingdom.

As regards these two possible explanations there is at present no definite information available, and it may be added that the pyro and creosotic compounds referred to can be altogether left out of account in Indian made spirits by reason of the different fuel, etc., employed.

By-products were given *without alcohol* on 188 occasions* with the result that slight headache occurred in 16 cases and vomiting in 2 cases. When it is remembered that relatively large amounts of these generally nauseous substances have been usually administered it is only remarkable that so few of the men were thus affected.

These experiments, therefore, go to show the harmlessness of these by-products when consumed in the quantities encountered in alcoholic liquors, and even in much larger amounts than are ever known to occur in such liquors.

Conclusions as regards noxiousness of by-products

But the chief by-products of alcoholic liquors are undoubtedly noxious when consumed in amounts *far exceeding* those ever found in potable liquors.

In the relatively small quantities found in even the worst samples of liquor analysed their action would appear to be unimportant and practically negligible.

A fair analogy might be drawn between the effect of these by-products which form the natural flavouring agents of potable liquors and that of oil of bitter almonds which is widely used as an artificial flavouring agent. Oil of bitter almonds in itself is, in sufficient amounts, exceedingly poisonous containing as it does such ingredients as prussic acid and benzaldehyde. The small amounts in which these poisons occur when this oil is used as a flavouring agent have no appreciable noxious effect. So also with the by-products in the small amounts in which they occur in potable liquors.

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* These include the few cases in which the by-product had to be dissolved in a small quantity of alcohol in order to render its administration possible.

APPENDIX TO SECTION C.

LIST OF QUESTIONS DRAWN UP FOR THE EXCISE COMMITTEE.

(1) What kind of spirits or other forms of alcoholic beverages are chiefly consumed in your district (*i.e.*, spirits of fermented liquors made from rice, *mahua*, millet, *gur*, toddy, molasses, etc.) ?

(2) Are the spirits obtained from outstills or from distilleries ?

(3) Can you give any information as to the practices obtaining with regard to alcoholic consumption as regards the following points :—

- (*a*) Can you ascertain and state how much is consumed daily on an average by a moderate drinker of spirits or other fermented liquor (*pachwai*, *tari*, &c.) ?
- (*b*) Is the amount consumed in the evening usually; or at any other particular time, or is it taken throughout the course of the day ?
- (*c*) On the occasion of fairs or other festivals, is drunkenness specially prevalent in your district ?
- (*d*) Can you give any idea what would be the average amount of liquor consumed per head at such private or public festival ?
- (*e*) Is it usual to dilute to any extent the liquor consumed ?

(4) Does the consumption of any particular kind of alcoholic drink interfere seriously with the consumer's power to resume work next day ?

(5)* As the quality of a liquor is believed to be shown more by the character of the onset of the symptoms as also by the after-effects, can you give any information on the following points ? Thus :—

- (*a*) Does any particular liquor in your district speedily produce helpless intoxication even when consumed in relatively small amounts ?
- (*b*) Is recovery from such intoxication particularly slow ?
- (*c*) Are there any particularly noticeable after-effects, such as loss of appetite, altered temper, long continued drowsiness or trembling ?
- (*d*) Have you any experience in your district or elsewhere with reference to any connection between apparently purposeless crimes of violence and the character of the liquor consumed ?
- (*e*) Any maniacal or other exceptional mental states following the use of a particular alcoholic drink ?

(6)* Can you state any *unusual* conditions referable to the use of any particular alcoholic liquor in your district or elsewhere ?

(7)* Have you any knowledge of cases of alcoholic neuritis among natives ? If so, would you kindly briefly state your experience in this connection ?

(8)* Have you observed any symptoms *specially* referable to the action of any particular liquor on any special system, *e.g.*, digestive, renal, nervous (including changes in mental and moral states), generative, &c. ?

(9)* Do you know of any definite diseases referable to the consumption of Indian manufactured liquors differing from those produced by European spirits ?

(10)* Is there any variety of country spirit with which you could connect these specially ?

(11)* Is "doctoring" of spirits with *nux vomica*, datura, tobacco, aconite or other drugs known to be employed in your district ?

(12) Have you any knowledge of confirmation of such adulteration by analysis of the liquors by a Chemical Examiner to Government or other analyst ?

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* Questions 5 to 11 and No. 16 are intended to be answered by medical men.

(13) Can you give any information as to natives' ideas of the relative harmfulness or harmlessness of any particular variety of alcoholic drink ?

(14) Is there any marked preference—apart from cost—in your district for country spirits over imported spirits or those made in India by European methods of manufacture ?

(15) Is drunkenness commoner during any particular season (*e.g.*, *tari* season) ?

(16)*Have you, from personal observation or hearsay, formed any opinion as to whether *pachwai tari* or other fermented liquor produces worse effects in general than spirits or *vice versâ* ?

(17) Have you any other observations to make not included in the foregoing list of questions ?

D.

EXCISE SECTION.

Chapter VII.—Standards, and Excise tests, of quality.

Chapter VIII.—Obscuration of alcoholic strength.

Chapter IX.—Excise Hydrometers, etc.,—standardisation, present degree of accuracy, etc.

Chapter X.—Increase of Alcoholic strength in spirits on keeping under certain conditions.

Chapter XI.—Reduction and Blending Wastages.

Chapter XII.—"Dyeing" for identification of duty-paid liquors.

Chapter XIII—Maturing of Spirits.

Chapter XIV.—Poisoning of *Bakhar*, *Pachwai*, etc., and nature of certain yeasts used by natives.

CHAPTER VII.

STANDARDS OF PURITY AND EXCISE TESTS OF QUALITY.

Except as regards content of acids and furfural, Indian-made spirits compare very favourably with good quality imported spirits.

Spirits.—The results shown in Chapter III indicate that, as regards the proportion of by-products, Country spirits compare favourably with even the best qualities of Imported spirits and with Indo-European spirits except as regards the quantities present, in many cases, of acids and furfural. The proper remedy as regards the latter defects is improved manufacture rather than control of quality by tests carried out by the Excise to ensure conformity to a fixed standard of purity.

Remedy for high acidity and furfural amounts lies in improved manufacture.

Adequate training of distillers and Excise Superintendents essential.

The removal of these defects is a comparatively easy matter. It merely involves the exercise of ordinary knowledge and care on the manufacturer's part and of *skilled* supervision on the part of the Excise authorities. The present state of manufacture in native distilleries by usually archaic and exceedingly wasteful methods and without any intelligent conception of technical requirements either on the part of manufacturer or Exciseman should, of course, no longer be allowed to continue. The remedy lies in adequate instruction of the Excise officers entrusted with the supervision of distilleries with regard to the conduct of proper spirit manufacture in order that they may be able to know when manufacture is being conducted wrongly and in such a manner as to interfere with the outturn of a wholesome liquor. Similar opportunities should likewise be afforded to native distillers of receiving instruction at a Central Distillery School; and in addition the Excisemen should receive some much required teaching as to the proper methods for ensuring adequate Excise control. There are a number of technical operations connected with the latter that at present no attempt whatever is made to teach (except in Madras) and the consequence is wasteful and very defective Excise control. The details in connection with this matter are dealt with in Chapter XVIII.

Standards of quality in other countries.

Standards of Quality.—Attempts have been made from time to time in various countries to impose standards of purity for liquors. The object in view has been either control of what I may term :—

1. *Hygienic quality* or of
2. *Commercial quality.*—

In the first case *maximal* limits for one or more groups of by-products have been fixed and by Excise tests an attempt has been made to enforce conformity to these. As regards Commercial quality, the aim has been the opposite, *i.e.*, *minimal* limits for by-products have been imposed with the view of attempting to guarantee the genuineness of the liquor. These points will further be dealt with later in this Chapter.

It is unnecessary to enumerate in detail the standards that have been prescribed in various countries, but a few illustrations will serve to indicate the results.

Germany and Brazil.

In Germany and Brazil a standard was fixed, found unworkable and abolished.

Belgium.

In Belgium the question appears not yet to be settled and the limit formerly imposed has been found very unsatisfactory.

Russia.

In Russia, where spirit manufacture is a Government monopoly, it is stated that the limit works fairly satisfactorily. The information obtainable has been, however, quite insufficient to enable me to draw any conclusions as to this.

Switzerland.

In Switzerland, which is quoted as a country in which the question has been satisfactorily solved, it is to be noted that the official method for estimating "fusel oil" in potable liquors is quite misleading. It will be sufficient to add that the

Swiss standard would, for example, reject all genuine whiskies and admit whiskey-flavoured patent "neutral" spirits, as was shown in the evidence given before Lord Playfair's Commission on British and Foreign Spirits.

France.

In France attempts have been made to judge of the quality of spirits by the so-called "co-efficient of impurities" which is the sum of the amounts present of acids, ethers, aldehydes, furfural and higher alcohols. But a Committee appointed by the French Minister of Commerce in 1904, has reported (*Moniteur Officiel de Commerce,* June 30, 1904) that the range of impurities in genuine spirits is much too wide to be any guide. It is evident that an analytical factor that varies from 25 to nearly 1,200 is valueless. The Committee are hence "unable to recommend that any limit should be fixed."

United States of America, and Lagos.

The United States of America have fixed *for fusel oil* a limit of 0·25 per cent; and *the Lagos Administration* in 1903 fixed 0·5 per cent. In any case, the prescription of such limits as regards "fusel oil" is futile and is based on a lack of realisation of the fact of its comparative harmlessness when present in even very much larger amount than that of any limit hitherto fixed by any Government or that is encountered in spirits on analysis.

Recent prosecutions in England for sale of "spurious" brandy and whisky.

We have recently had in England evidence of the difficulties involved in any attempt to fix standards of purity in spirits. Some time ago a conviction for the sale of *spurious brandy* was obtained in London which was based on a standard of 80 parts of ethers per 100,000 of absolute alcohol. That is to say, that a sample of brandy containing less than 80 parts of ethers was held to be a spurious brandy. Mr. Otto Hehner, one of the best known analytical authorities in Europe, has given his opinion* that "In undoubtedly genuine brandies ether-coefficients have been found as low as 18 and as high as 450"; and I can certainly confirm the accuracy of this statement. Mr. Hehner points out further that genuine brandies produced in Spain, Portugal, Australia, etc., have much lower ether-values than French brandies as a rule.

Then again *as regards whiskies,* evidence was adduced in the North London Police Court this year that certain so-called Scotch and Irish whiskies were practically patent-still spirits. The analytical basis of calculation was that genuine pot-still whiskies should contain not less than 380 parts (per 100,000 of alcohol) of *total* by-products, and on this basis the samples were reported to be composed almost entirely of patent-still spirit. The defence admitted the accuracy of the analyst's opinion and a conviction was obtained. Thus samples of so-called Scotch and Irish whiskies containing such a disproportionately large quantity of patent-still spirit were held to be falsely described and a fraud on the consumer. Had the amount of patent-still spirit been markedly less than it was, a conviction based on analytical results would have been impossible but the case selected for prosecution was an extreme one.

Fallacy and dangers of standards employed in such cases.

The fallacy which underlies all attempts to fix such standards is this—given a fixed legal standard for total by-products, "fusel oil" or any other constituent and the sophisticator straightway proceeds, with the assistance of the chemist, to add to his spirits the required amount of by-products to bring them above the legal minimum†; or, in the case of a maximal standard, he dilutes to the required degree with pure patent-still spirit. In this way a very undesirable impetus is given to the systematic "doctoring" of spirits and the law is at the same time easily and successfully evaded. This objection would, of course, not have applied to the Government of India's proposal to fix standards and tests for distillery liquors, as Excise supervision in the distillery and bonded warehouses would have prevented adjustment of the liquor to any fixed standard and further the tests would have been applied to the liquor either when freshly distilled or on issue from bond.

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* "Analyst," February 1905, page 41.

† As a matter of fact, certain cheap brandies are now sold to "the trade" with a "guaranteed content of 8 per cent. of ethers," in order to conform to the above-mentioned standard.

Standards and tests of quality are unnecessary and undesirable at present.

But fortunately the results obtained in the course of this enquiry enable me to leave aside this vexed question of chemical standards altogether. The physiological experiments conducted here and described in the preceding chapter would alone enable me to say that the proportions of by-products found on analysis in any of the many different types of spirit examined here are present in quantities which are quite negligible as regards deleterious action.

Furthermore, I have already shown that the amounts of by-products present (except in the case of acids and furfural—the proportions of which are the most easily controlled of all others by improved manufacture) compare well with the quantities found even in the best classes of imported spirits and of spirits made in India by European methods.

It is, therefore, satisfactory to be able to advise against the imposition of standards and of quality tests.

Prevailing character of cheap imported spirits is that of flavoured patent-still spirit.

Cheap Imported Spirits.—It has been shown in a previous chapter that these chiefly appear to be "plain" or "neutral" spirits made in a patent-still from any cheap fermentative basis and flavoured either with essences of brandy, whisky, rum, gin,† etc., or with small proportions of these spirits (generally new and on that account cheaper and stronger flavouring agents.)

Nearly all cheap imported spirits are much weaker alcoholically than the spirit they counterfeit.

Excluding a sample of "rectified spirit," 25 out of the 26 samples recently examined by me were below 40 U.P., 16 were below 50 U. P. and 12 below 60 U. P. Whereas, then, all the imported samples of ordinary quality and higher price that I examined were above 25 U. P. only one sample of the *Cheap* Imported spirits was over this limit *

In the United Kingdom, therefore, these 25 samples would have been condemned as being below the prescribed minimum limits for alcoholic strength (25 U. P. for brandies, whiskies and rums, and 35 U. P. for gins). The vendors could thus have been convicted on this score under the 6th section of the Sale of Foods and Drugs Act, 1875, for failing to supply their customers with an article of the "nature, substance and quality demanded."

If the minimum strength for all imported spirits is raised to that of the spirits they imitate it is probable that their import would practically cease.

If the Government of India were to adopt the view that these cheap imported spirits are frauds on the purchaser and that flavoured patent-still spirit is not whiskey, brandy, etc., then it is probable that the enforcement of a minimum strength as in Britain would tend to stop the importation of such factitious spirits. The margin of profit on these would scarcely allow of the increase of alcoholic strengh to 25 U. P. as the following seems to show :

Rectified spirit, 64° O. P., costs (including duty) on an average Rs. 14-8-0 per gallon in Calcutta.

A sample of so-called brandy, bottled in Calcutta and labelled "produce of Germany" would appear to be German silent spirit flavoured with brandy-essence (or more improbably with cheap brandy). It is sold at Rs. 8 a dozen, or about 11 annas a bottle. Its strength is 64·2° U. P. The value of the alcohol in it is Re. 0-8-6, which leaves a margin of 2½ annas for flavouring, bottling, labelling, etc., and profit ; or roughly, 30 per cent. of the value of the alcohol in it.

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* In the United Kingdom potable spirits are generally bonded at 11·O. P. and sold at this and down to 25·U.P. but Rum is manufactured at from 10—43·O. P.

Industrial "spirits of wine" must be at least 43·O. P., and are generally sold at 54 to 64 O. P.

† Gin differs from whiskey, brandy and rum in being, in even its best descriptions, grain spirit treated with essences of various kinds and then re-distilled.

Another sample of patent-still spirit labelled "Brandy" is apparently imported from France, but is in all probability bottled, wired, capsuled and labelled in Bombay. Its retail price is Rs. 1-6-0, and the value of the spirit in it is about Rs. 1-1-0: again a margin of about 30 per cent. on the value of the alcohol.

The profits on such spirits would, on this basis, not appear to be exorbitant.

Cheap imported spirits and Indo-European patent-still spirits made to imitate whiskey, etc., are much on the same plane.

It would, however, be inconsistent, even were it considered advisable, to attempt at present to exclude these cheap spirits on the ground that they are chiefly composed of patent-still spirits and are not genuine articles. For Government have for several years past approved of the issue of flavoured patent-still spirits from distilleries under their control, these "imitations" being placed on the market as whiskey, brandy, etc. This they are not, unless we are to extend the definition of whiskey, brandy, etc., so as to include spirits, possessing the odour and taste of such and obtained in whatever manner.

There is no doubt that the prevailing ideas regarding certain foods and alcoholic beverages are being widened to an extent which in the hands of unscrupulous dealers is coming to be a public danger. Brandy, for instance, should be a wine-distillate but in the majority of the brandies sold now-a-days this is not the case. Similarly it would almost appear as if whiskey was coming to mean not, as formerly, a distillate from malted grain made in a pot-still and matured by storage, but also "blends" of such spirit with neutral patent-still spirit; and this widened acceptation has now been carried to such extremes that many whiskies consist almost entirely of patent-still spirit flavoured either with a small admixture of more or less freshly-made and hence "raw" pot-still whiskey or with chemically-prepared essences.

Blending no longer means the mixture of different spirits of same kind but also has come to include dilution with patent-still spirit.

Formerly the term "blend" signified solely the mixture of different spirits of the same kind, *e.g.*, an older and more matured spirit with a newer and rawer spirit. The object of this was to suit the consumer's taste and to cheapen the cost of production, as the whole bulk of spirit had not to be stored as long. But now-a-days this term has largely come to mean the dilution of a highly-flavoured and often newly-distilled pot-still spirit with featureless patent-still spirits, partly in order to make the taste blander but principally in order to lessen the cost of production, and so to increase the profits on its sale. The patent-still produces spirit at a very high strength from a large range of fermentative bases—potatoes, beets, sawdust, rice, rye, oats, wheat, or other cereals—and the source of such patent-still spirit cannot be detected by chemical analysis when rectification has been efficient. It is thus very profitable to substitute such cheaply produced spirit (made perhaps from waste material, *e.g.*, damaged potatoes or grain) for malted barley which is relatively an expensive base.

The public are completely and necessarily in ignorance as to what proportion of patent-still spirit (if any) is present in their whiskey, etc., and the trade claim that they are providing a mild spirit which is preferred by the public in general* to the strongly flavoured pot-still spirit which is much more expensive to produce (and on which the profits are much less). We seem, therefore, to be drifting to a state of affairs in which whiskey will come to mean a "spirit tasting and smelling like whiskey."

Again as regards brandy, this is esteemed by the public and prescribed by the medical profession for certain special properties which *genuine* brandy is believed to possess in a higher degree than does any other spirit. But it is only in rare instances and at comparatively high prices that really genuine brandy is procurable. The patent-still here again has tended to oust the genuine medium priced wine-brandy from the field by reason of the former's advantage as regards cheap production, and the ignorance of the public as to what genuine brandy is and ought to be.

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* This was the defence offered in the prosecutions in London referred to above. It is the attitude taken by a large section of the trade, and in virtue of which the conviction has been appealed against.

Brandy-flavoured patent still-spirit cannot be regarded as "brandy."

It can scarcely be claimed that a patent-still spirit artificially compounded to resemble brandy is brandy as understood by the public in general. It may be so compounded as to conform to all analytical requirements, but the best practical test in such cases—trained observation of the taste and bouquet of the spirit—is infinitely more discerning in this instance than any chemical analysis.[*] That is to say, that as regards *commercial quality* (which depends on the presence of proportions of naturally-produced and inimitable flavouring and odoriferous substances which occur in too minute quantities even for chemical analysis) the skilled taster is to be relied on; whereas for *hygienic quality*, where one is dealing with relatively large proportions of various analysable ingredients chemical analysis is essential.

It appears that such opinions as at present obtain as to the necessarily inferior hygienic quality of cheap imported spirits have been hitherto chiefly based on the consideration that because the valued characters (*e.g.*, delicate bouquet, mellow taste, etc.) of the more expensive spirits are absent in the case of the cheaper and more or less factitious varieties they, therefore, are also of correspondingly noxious quality. In other words, that because they are "cheap" they must be "nasty" (*i.e.*, deleterious). As a matter of fact, most of these cheap spirits may be claimed to be "purer" (*i.e.*, to have less by-products); and to be also, from the point of view of containing less alcohol, more wholesome.

Possible objections to chemical analysis in this relation.

This appears to be true as far as chemical analysis can afford evidence, though it may be argued that chemical evidence may possibly be insufficient to decide differences of such minuteness. There may be differences of composition at present undetectable by chemical analysis which in the long run may have a physiological effect. But there is no definite evidence for such a view at present.

At all events, the holders of the view that "cheap spirits" are necessarily deleterious may claim in their favour what appears to be the underlying principle of the Food and Drugs Act, *viz.*, that articles of food that have been made in a particular manner and consumed freely for ages carry their own guarantee to the purchasers and that nothing else differing therefrom in a radically different manner, even though it has in the main the same chemical composition, shall be substituted (unknown to the consumer), simply for the reason that such substitutes cannot carry with them the same guarantee derived from long usage. This principle should logically have debarred the addition of patent-still spirit to potable spirit at the outset, but the profits to be made were great and the risk of detection practically *nil*.

It is a moot point at present whether such mixed spirits have been sold for a sufficiently long time to have earned their own guarantee of harmlessness. It is apparently this aspect of the matter upon which the English Appellate Court will be asked to decide in relation to the mixtures of pot-still and patent-still spirits now sold at home without any indication that they are other than the original "all pot-still" spirits as sold 50 or 100 years ago.

Cheap imported and Indian-made imitation spirits.

The general argument applies, of course, to the cheap imported spirits and with special force to the entirely factitious spirits made in India by flavouring patent-still spirit with so-called essences. In regard to both of these classes, however, it is to be noted that the price charged for them bears at least some relation to the commercial value of the alcohol they contain. It may also be argued that there is no ground for interference with these imitation spirits as the public who purchase "Scotch whiskey made in Germany" or "Fine Champagne Brandy" made, say, in Bristol or Calcutta, at or about one rupee a bottle, must know that they cannot get a genuine article at that price.

The question of quality has to be considered both from the commerical and hygienic standpoints.

Their source of origin is clearly set forth on the label in each case so that "he who *drinks* may read."

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[*] "We judge nearly all our food-stuffs, certainly all our "Genussmittel" (*i.e.*, "delicacies,") as distinguished from "Nahrungsmittel" (*i.e.*, staple foods), by our senses of taste and smell, and not by analysis. We cannot distinguish the cheapest from the most expensive wine by analysis; I know of no analytical difference between a half-penny and a one-shilling cigar, nor between the cheapest tea and the finest. Flavours have been and are still, in most cases, beyond our analytical grasp."

(O. Hehner, "Analyst," February 1905, page 40).

Further, it is now clear that such spirits are much weaker in alcohol and contain a much smaller amount of (so-called) "impurities" or by-products than the higher-priced genuine spirits. So that they may even be claimed to be hygienically "purer" than the spirits they imitate, and hence rather to be encouraged than otherwise.

What call, then, is there for the State's interference in such a case? It may be answered to prevent a spurious article from being foisted on the public in place of the real. But it has then to be considered what constitutes the "real article." It has been stated (and my analyses amply support the statement) that a very large proportion of, for example, whiskies are at present mixtures of usually largely preponderating amounts of "plain or neutral" patent still spirit (which no one surely can claim to be "whisky" by itself) with varying proportions of pot-still whisky, this last being used to flavour characteristically the usually preponderating bulk of plain spirit. This mixture is then sold at a price usually *little if at all less than a whiskey which is entirely pot-still spirit* and which conforms in general to the conditions under which whiskey was originally made and gained favour with the public.

Case of dilution especially of high priced spirits with patent-still spirit.

Is patent-still spirit then to be excluded from whiskey? Patent-still spirit is not whiskey and should not be present in whiskey but some concession would appear now to be necessary in view of the fact that a section of the public has come not to object to have its whiskey so diluted.[*] If the consumer continues to concur in this, little more is to be said. It remains to be seen, however, if in the light of recent Police Court revelations on this point the consumer will do so.

Then where is the line to be drawn: at an admixture with, say, 50 per cent. of patent-still spirit or at 95 per cent.? If the recent London decision is upheld then a standard will have to be fixed as to this and at present steps are being taken to obtain the appointment of a Royal Commission to investigate this question.

Practically, no "hygienic" difference exists between the different classes of Imported and of Indo-European spirits.

It would appear, then, that as far as our scientific knowledge leads us at present there is little or no reason on *hygienic grounds* to discriminate between (1) the good quality imported spirits (with a few exceptions); (2) the cheap imported spirits; and (3) the factitious Indo-European spirits. They all (with a few exceptions in the first class) differ more or less from the original types of long-matured all-pot-still spirits, and accordingly have not the guarantee of long usage. Apparently only the gradually accumulating experience derived from continuous long consumption will finally decide whether any of the three classes is *hygienically better or worse* than the others.

Cheap imported spirits are of very inferior *commercial* quality but are by no means correspondingly deleterious.

How, then, are the frequently repeated denunciations of cheap imported spirits as "vile," "poisonous," etc., to be explained? Apart from trade-prejudices, which naturally will attach to a cheaper article which appears to undersell the ordinary quality, there has been very little opportunity afforded to the public for forming any opinion founded on facts on this matter. In, for instance, high class brandies it is the flavour (which can only be obtained by ageing a good wine-distillate) which gives the commercial value to the spirit. The *flavour* of a cheap imported brandy not being in any respect comparable to that of a genuine well-matured brandy the latter will naturally continue to be preferred by those who attach sufficient importance to flavour and who can afford to indulge their tastes.

The "good quality" (or, more strictly, high-priced) imported spirits claim superiority on aesthetic grounds, *i.e.*, mellowness, flavour, etc. The others do not and there is a corresponding difference in price, but this, of course, is no proof of their injuriousness. It is true that the high-priced imported spirits also claim superiority on hygienic grounds which may possibly be conceded to some brands but, as regards the majority, trade admissions make it clear that the claim cannot be admitted, without also allowing it equally to the avowedly cheap spirits.

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[*] The difference in cost price between pot-still and patent-still whiskeys is stated to average from two shillings to half a-crown per gallon. 10 per cent. of pot-still to 90 per cent. of patent-still spirit is a frequent proportion but of course, very wide ranges occur.

If patent-still spirit is permissible for dilution then why not for total substitution as in cheap spirits?

The argument even stretches a little further. It is stated by the "trade" that patent-still spirit is now-a days added to pot-still spirit to render it more acceptable to the modern palate and stomach (*i.e.*, to dilute the strongly flavoured by-products). A section of the trade defends the practice on these grounds even when the patent-still spirit amounts to 95 or 99 per cent. of the whole. How, then, does mere patent still spirit (*i.e.*, 100 per cent.) as in the case of imitation spirits suddenly become "rank poison?"

Possible deleteriousness of flavouring agents used.

Quality of flavouring agents.

The only remaining reason for such a charge is the nature of the flavouring essences used. As regards Indo-European spirits, I have urged that this matter should be controlled throughout India by the Excise as has been done for several years past in the Madras Presidency. As regards cheap imported spirits, doubtless in some cases raw whiskey itself is the flavouring agent. Such spirits are thus identical with certain high-priced imported spirits (except as regards alcoholic strength). It has been impossible to collect direct evidence as to the nature (deleterious or otherwise) of essences used in, say, the cheap imported spirits from Germany. Some of these flavouring agents are known to be deleterious owing to the presence of various aldehydes. The results of my analyses of the cheap imported spirits show that aldehydes are in the main conspicuous by their absence: 18 out of 27 samples showed no aldehydes or very faint traces. Out of the remaining nine, eight samples contained very small amounts of aldehydes and only one sample a moderate amount. Accordingly the result of analysis indicates no ground for alarm and what I have already said at page 147 about by-products and oil of bitter almonds as flavouring agents may be also considered in this connection.

Conclusions.—To sum up as regards these cheap imitation spirits imported into India the question would appear to resolve itself into one either of—

(*a*) *commercial quality*, *i.e.*, is the sale of a spurious spirit to be interdicted as being a fraud on the consumer? or

(*b*) *of hygienic quality*, *i.e.*, are these spirits specially deleterious in their effects?

As regards (*a*), there is a clear indication on every label of imported spirit of the country of origin (as required by the Merchandise Marks' Act) so that any one who buys a bottle of "Scotch whiskey made in Germany" at a rupee must be presumed to have acumen sufficient to know that he is not getting Scotch whiskey. But there is the point of alcoholic strength. If these spirits are often less than half the minimum strength of the spirits they purport to be is this not, commercially, a fraud? The answer to this would appear to be in the negative in view of the fact that the price charged is correspondingly low and is in due proportion to the commercial value of the alcohol present.

If, however, Government consider that these spirits should conform as regards alcoholic strength to the standard of the spirits they imitate, then it would appear to be easy to enforce a minimum limit, as in Britain, of 25 U. P. for brandy, whiskey and rum, and of 35 U. P. for Gin, but the price would then correspondingly increase. Furthermore, the present ready means of distinguishing between the two classes would tend to disappear and the consequence probably would be that unscrupulous vendors would fraudulently substitute the one class for the other.

As regards (*b*), hygienic quality, these spirits have been shown in general to contain smaller proportions of by-products than the genuine spirits and to have a much lower alcoholic strength. Hence there is every reason to believe that, in the light of the information now available on the subject, they are at least no more injurious in their effects, and from this point of view also there would appear to be no case for interference.

Case of Indo-European patent-still spirits produced to imitate brandy, whisky, &c.,

More especially is this the case as regards those Indo-European spirits which consist of patent-still spirit flavoured to imitate brandy, whiskey, etc., with which there would, *under present conditions*, seem to be no reason for interference. So long as cheap spurious liquors are allowed to be imported to compete with the better class of imported spirits it may be argued that it is only fair to the Indian manufacturer to allow production of an article that will compete with (especially the cheap) imported spirits. In any case all such Indo-European spirits have their origin clearly stated on the labels so that any one consuming Indo-European " whiskey " should know that it cannot be genuine "Scotch" or "Irish" whiskey and very little enquiry would elicit its true nature, *viz.*, a spirit made usually from sugar-residues and artificially flavoured to resemble genuine whiskey, etc.

Label descriptions at present clearly indicate place of manufacture.

The question thus comes to be in great measure one of definitions and standards. Are we to continue to designate as whiskey, brandy, &c., artificially flavoured patent-still spirits which have none of the hitherto recognised characters (as regards origin) of brandy, whiskey, etc. ? The answer would appear to be that so long as an article does not bear a manifestly false trade description (as, for instance, in the case of a German-made spirit described as Scotch or Irish whiskey) there would appear at present to be no case for interference.

It will be found at present practically impossible to limit the use of the generic terms "whiskey," "brandy," etc., so long as they are used without some such false and misleading prefix or affix as above indicated.

It may be added that the above conclusions as regards cheap Imported spirits, based on a *de novo* re-examination of the subject, are identical with those formerly arrived at by me when demi-officially reporting, in 1902, on the subject to the then Finance Member of Council (Sir Edward Law) ; and, in 1901, to the Bengal Excise Department.

CHAPTER VIII.

OBSCURATION OF ALCOHOLIC STRENGTH.

Method of calculating obscuration.—The "apparent strength" (*i.e.*, the alcoholic strength as given by the standard hydrometer when the sample is first examined) is subtracted from the "real strength" (*i.e.* that given by the specific gravity of the same sample *after distillation*). This difference is the obscuration of the sample and is not returned in my reports. What appears there is the actual obscuration *calculated as a percentage of the real strength for each sample, i.e., the percentage obscuration*; in other words, the percentage of the whole alcohol in any bulk of the sample that is obscured.

1. Country Spirits.

Varieties of obscuration.

Varieties of obscuration.—Obscuration may be due to three causes :—

1. A relatively high amount of *volatile* acidity, caused by bad methods of manufacture or arising from the souring of a spirit too weak in alcohol.
2. *Fixed* acids and other soluble substances absorbed from the cask.
3. *Compounding*, *i.e.*, the addition to the spirit of sweetening, flavouring, colouring (as by caramel) or other substances.

At present No. 1 is the main cause of loss of Excise revenue from obscuration in India.

If modernised central distilleries and supply bonded warehouses are introduced widely, No. 2 will become one of the chief causes of obscuration.

No. 3 is already provided for, if the Excise Regulations on this point are properly carried out.

Acid obscuration.

Acid obscuration.—The extent to which volatile acid causes obscuration in country spirits is a point which Indian Excise Administrators would appear to have hitherto ignored or underestimated. It is in country spirits, as will be seen, a serious cause of obscuration in many cases, and the relation between high acidities and high obscurations, as also the relation to proof strength, is shewn in the following table :—

Number of samples examined.	Strength.	Average percentage proof strength.	Acidity: parts per 100,000 of alcohol.	Obscuration, *i.e.*, percentage of real alcohol obscured.
				%
25	Proof *i.e.*, ranging from 2° O. P. to 4° U. P.	100% proof ...	174·4	1·2
52	10° U. P. (*i.e.*, 5°—19° U. P.)	90% proof ...	200·9	1·5
127	25° U. P. (*i.e.*, 20°—29° U. P.)	75% proof ...	240·8	1·87
24	40° U. P. (*i.e.*, 35°—45° U. P.)	60% proof ...	420·2	2·2
29	50° U. P. (*i.e.*, 45°—55° U. P.)	50% proof ...	583·5	2·9
59	60° U. P. (*i.e.*, 55° U. P. and lower)	40% proof ...	973·4	3·55

There is accordingly a constant loss by obscuration due to the large amount of acetic acid formed under present conditions of manufacture, and there is no attempt made to meet this loss. As has been explained, this obscuration is only attributable to this source. The spirits were nearly all received from the distilleries in bottles or jars and practically fresh, so that the obscuration is not due to absorption from a cask. In the stronger spirits the amount is not great, but becomes important in the weak spirits. The importance of this point will be evident from an examination of the table on page 163 where it is shown that the quantity issued of weak spirits (with high obscurations) is much greater than that of strong (and less obscured) spirits. Roughly, fourteen times as many proof gallons are issued below proof as at or over proof. The above results are averages on the whole body of samples tabulated to show the constant average loss.

Whilst the general law holds that weak spirits contain most acid and hence show highest obscurations, it must not be supposed that high strength spirits do not give at times quite large obscurations from this cause. A number of 25° U. P. spirits and also of higher strengths contained amounts of acid which were 2, 3 or 4 times as great as the average, with correspondingly large obscurations.

In certain instances the loss is much greater than the average would indicate.

Country spirits' obscuration.

Country spirits' obscurations.—Of 351 samples, 24% gave under 1% of obscuration; 50% are obscured to the extent of from 1 to 3% of the total alcohol; 15% have 3 to 5% of obscuration; and the remaining 11% range from 5 to 10% of obscuration (excluding 8 analyses of compounded liquors separately detailed at page 164).

It is evident that if, for example, the distilleries represented by the 11 per cent. (with obscurations from 5 to 10%) turn out a disproportionately large amount of spirit, the loss by obscuration is a somewhat serious matter.

Statement showing the strength at which country spirits are issued in the several Provinces and the proportion borne by each strength to the total issues.*

No.	Province.	Proof and over.	Between 1° U.P. and 20° U.P.	Between 21° U.P. and 30° U.P.	Between 31° U.P. and 40° U.P.	Between 41° U.P. and 60° U.P.	Between 61° U.P. and 80° U.P.	Between 81° U.P. and 90° U.P.	Total quantity in proof gallons.
1	2	3	4	5	6	7	8	9	10
1	Bengal	...	373,916	95,118	53,519	197,693	667,123	252,408	700,100
2	United Provinces ...	108,073	...	1,783,340	...	...	...	...	1,445,578
3	Punjab	316,860	45,302	...	...	...	4,004	...	363,839
4	North-West Frontier Province.	18,678	...	...	...	...	...	...	18,678
5	Madras	...	203,350	1,465,586	36,808	172,154	...	...	1,279,537
6	Bombay	...	550,780	1,597,446	2,114	1,859,754	...	...	2,383,878
7	Central Provinces ...	...	7,573	31,037	3,773	411,088	283,995	...	339,387
8	Berar	...	...	54,152	...	461,223	...	...	225,066
	Total bulk gallons ...	443,611	1,180,921	5,026,679	96,214	3,101,912	955,122	252,408	6,756,063
	Total in L. P. ...	444,290	963,537	3,696,267	62,386	1,293,256	254,056	42,271	6,756,063
	Percentage to the local issues	6·6	14·3	54·7	0·9	19·1	3·8	0·6	100·0

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* I am indebted to the courtesy of the Secretary, Excise Committee, for the above statement.

The absolute remedy against the obscuration due to volatile acidity lies in improved conditions of manufacture. With greater centralisation of distilleries, efficient plant, reasonably skilful manufacture and expert inspection, etc., the question of obscuration *quâ* acidity would hardly arise in practice for the reason that the acidities would be low in such spirits (as already shown in connection with Indo-European spirits).

In compounded spirits the existing practice of determining alcoholic strength before compounding would, of course, still have to be followed. It may be added that I know of cases in which this obviously essential procedure is neglected.

As showing the effect of compounding on obscuration the following series of compounded spirits from Uran distilleries, Bombay, are here given. These are the highest obscurations that have been encountered in the course of my Investigation.

	Obscuration.	Apparent alcoholic strength.	True strength.
(1) Rose, superior quality	77·1 per cent.	84·6 U. P.	32·6 U. P.
(2) Do., inferior do.	87·0 ,, ,,	91·2 ,,	32·3 ,,
(3) Mosambi (sweet lemon), superior quality	71·5 ,, ,,	80·3 ,,	30·5 ,,
(4) Ditto, inferior do.	85·3 ,, ,,	90·1 ,,	33·0 ,,
(5) Elachi (cardamom), superior quality	82·2 ,, ,,	87·8 ,,	32·0 ,,
(6) Ditto, inferior do.	84·1 ,, ,,	89·0 ,,	31·7 ,,
(7) Red masala (miscellaneous spiced), superior quality, ...	82·7 ,, ,,	88·4 ,,	32·0 ,,
(8) Ditto, inferior do. ...	84·4 ,, ,,	89·5 ,,	32·6 ,,

Casking obscuration.

Casking-obscuration.—Casked spirits at present *in general* scarcely remain long enough in bond to acquire an appreciable obscuration by absorption of soluble substances from the wood, so that the matter as regards this factor is not *at present* of much practical importance.

But if spirits be casked and transported over long distances to bonded warehouses and if the alcoholic strength is to be determined before issue from the latter, then a very appreciable amount of obscuration from the cask will occur. This point will, therefore, have to be considered in the general scheme for modernised central distilleries with district or other bonded warehouses, and means adopted for controlling this source of loss of revenue.

Use of vessels which would not yield obscuring substances to the spirit.

Use of vessels which do not yield obscuring substances to the spirit.—I have been somewhat surprised to notice how many of the samples sent to me for analysis here have been sent (often from very distant parts of India) in stoneware jars. If we could effect the substitution of these for wooden casks for carriage and also store liquor in distilleries and bonded warehouses in proper receptacles not made of wood it is evident that casking-obscuration would not occur.

I, therefore, suggested in my 22nd Report for the consideration of the Excise Committee that, in place of wooden casks for carriage, stoneware jars might possibly be substituted. I further pointed out that if these jars were made in India their cost would be very materially reduced, as at present the cost of carriage from home is one of the chief obstacles to their wider use. Their weight is another disadvantage but Railway and Government concessions regarding special rates of carriage might possibly tend to largely overcome this objection. The comparative difficulty of handling is another objection. This at first sight did not seem to be a difficulty in practice as appeared to be shown by the wide use made of stoneware jars by distillers and retailers at present in various parts of India; but nevertheless the fragility, weight and impossibility of rolling jars, etc., seem to make their general adoption impracticable.

The use of vessels which will not add obscuring substances to the liquor being, of course, the simplest remedy for casking-obscuration, I further considered the possibility of carriage in metal-drums. This, however, while a good method for "plain", high-strength, industrial spirits (with low acidities and consequently little risk of corrosion of the drum) would be certainly impracticable for many potable and markedly acid liquors. Not only would the taste be altered but obscuration would arise from solution in the liquor of the salts obtained by corrosion of the drum.

Thus the idea of preventing obscuration by the use of jars or drums had to be definitely set aside.

The process required for estimation of obscuration involves the distillation of a sample (the use of ice being generally necessary in India for this operation and this is, of course, in many places a very grave difficulty). The sample is then weighed in a specific gravity bottle on a chemical balance (as at present in the Customs) or its hydrometer strength is taken.

Proposed method for avoiding actual obscuration-estimations by the Excise.

Proposed method for avoiding actual obscuration-estimations by the Excise.—But I believe that we may possibly be able to avoid the troublesome procedure required for Excise obscuration-estimations by the following means: an extensive series of obscuration-observations should be made so as to determine the average increase of obscuration arising under the ordinary conditions obtaining in Excise practice in India. From the records of these obscuration-estimations, tables representing the *average obscuration arising in varying periods of exposure to casking, etc.*, could then be prepared.

All that the exciseman would apparently then have to do would be to read off on these tables the average obscuration by means of which he would proceed to assess the duty in any particluar case.

Excise obscuration-estimations.

In this way, it would become a matter of comparative indifference as to whether storage and carriage is in cask or not. All that it would be required to know would be the number of days during which the spirit had been casked, etc., which would be recorded on a tally on issue from the distillery.

At present, duty is levied on issue from the distillery when for retail sale and not to bonded warehouse. Otherwise, the duty is levied on issue from the bonded warehouse. By comparison of issues at distillery and bonded warehouse and by the further record of the number of days of casking allowed for in calculating obscuration sufficient control would be exercised to prevent irregular practices.

There is another device by means of which this difficulty might be got over which ought also to be thoroughly investigated when a chance occurs of so doing.

SUMMARY.

Thus, *casking-obscuration* might be dealt with in practice by one or other of the above methods.

Compounding obscuration would be controlled as at present arranged for by Excise regulations in general.

Acid obscuration would be minimised and would become negligible in practice by improved manufacture, checked by regular systematic tests of the degree of acidity, etc., of the outturned liquor, which tests could be arranged for in a very simple and inexpensive manner.

Indo-European spirits' obscuration.—The alcoholic strength is required to be determined before compounding or casking, so that the figures I have obtained may be of interest as a check and, further, as indicating in the examples of uncompounded spirits the amount of obscuration present.

Of the 37 samples examined—

(1) 11 samples (30 %) gave under 1 % of obscuration.
(2) 16 " (43%) " from 1 to 3% of obscuration.
(3) 6 " (16%) " " 3 to 5% "
(4) 3 " (8%) " " 5 to 7% "
(5) 1 sample (3%) " " 7 to 10% "

Obscuration in Indo-European spirits.

Of group (1) ten were uncompounded, and of groups (2), (3) and (4) one in each case was uncompounded.

It will be observed that 10 out of the 13 uncompounded spirits fall into the first group (under 1 % obscuration). The obscurations of the other three are due to casking, as their acidities are too low to account for the amount of obscuration found.

The influence of compounding is manifest from the fact that whilst 84% of the Indo-European spirits examined have low acidities (*i.e.*, under 100 parts per 100,000 of alcohol), yet only one sample falls within the obscuration group corresponding to this acidity. These spirits were *in general* sent in bottles or jars, and direct from the still, so that obscuration from casking is in most cases negligible. But if proved for alcoholic strength before being compounded, their obscurations are of no practical importance.

Cheap Imported spirits.

The amount of obscuration in the series of samples examined by me for the Excise Committee is shown in the following table—

Obscuration in cheap Imported spirits.

Up	to	1 %	4 samples.
1	to	3 %	2 ,,
3	to	5 %	4 ,,
5	to	7 %	4 ,,

Between 10 and 27 % 13 samples (from Calcutta).

The obscuration in all the samples of Calcutta cheap imported spirits is much higher than that found in imported spirits of ordinary quality or in the Madras and Bombay cheap imported spirits.

These cheap spirits were in 25 out of 26 cases below 40 U. P. whereas all the samples of ordinary quality of imported spirits were above 25 U. P.

Obscurations in Imported spirits (ordinary quality).

In Imported Spirits the amount of obscuration is estimated in the Custom Houses but my work here clearly indicates that the method in use is capable of much improvement and that a very definite loss of revenue is at present occasioned by the neglect of some special measures in connection with the distillation of the sample previous to proving its true strength.

INFLUENCE OF HIGH AIR-TEMPERATURES ON SPIRIT OBSCURATION DETERMINATIONS.

Inaccuracy of Customs' method of ascertaining amount of obscuration.—In the course of analyses repeated at intervals of certain samples of spirit it was found that a somewhat large increase in "real strength" during the period June to November became apparent and I have since ascertained the cause of this. For convenience three only of such instances are quoted.

Effect of high air temperatures on obscuration determinations.

—		I	II	III
		PER CENT.	PER CENT.	PER CENT.
A. Apparent strength ...	In July	57·4	43·9	43·1
	In November	57·1	43·2	42·4
	Alteration in four months ...	0·3 loss.	0·7 loss.	0·7 loss.
B. Real strength ...	In July	57·5	44·0	43·2
	In November	59·4	45·6	43·8
	Alteration in four months ...	1·9 gain.	1·6 gain.	0·6 gain.

A. shows that the spirits lost a small amount of alcohol by evaporation in the period July—November. These figures were obtained by the hydrometer which gives an accurate account of the change in spirit strength so long as no soluble matter (other than alcohol) is added to or removed from the spirit in the given interval, *i.e.*, as long as the obscuration remains constant. As these spirits were in bottle the fact certainly was—as shown by these figures—that a small loss of alcohol occurred.

B., however, indicates a notable increase of alcoholic strength in the same period of four months. The explanation is that the determinations of real strength made in June and July were underestimated and moreover the same is true of all the determinations of real strength made here in the hot weather. This fact has only become evident in the latter part of my investigation but the evidence, of which a summary follows, is quite convincing and proves beyond doubt the very disturbing influence that a high atmospheric temperature has on all accurate spirit analysis.

The observation was further verified in the course of re-analysis of a considerable number of spirits to determine the effect of ageing as well as in connection with the series of maturing experiments above quoted.

Stated briefly, evaporation-losses do not affect the hydrometer-determination because the bulk examined is large, its temperature is not artificially raised and the observation process is rapid. On the other hand in determining "real strength," and hence obscuration, a small sample must be distilled and recondensed quantitatively. The first few cubic centimetres of the distillate may be as strong as 90 per cent. by volume (and loss of alcohol at this strength is specially serious) and the whole process requires nearly two hours for completion. Hence the laboratory loss by evaporation may be very marked unless specially guarded against. In *temperate* climates the method is known to be perfectly accurate and Colonel Warden, my predecessor in the Chemical Examinership at Calcutta, investigated the process for the Indian Customs Department in 1890, *i.e.*, as regards imported spirits subject to rather high obscuration.

Obscuration underestimated in the Customs at present.

Dealing however with spirits containing little and sometimes no obscuration the laboratory loss by evaporation became evident to me in June and July and was met by a simple device which apparently removed the error. Comparison of analyses made in the end-months of the past year with those made in the hot months made it clear that losses averaging about 2·5 per cent. of the whole alcohol in any given sample had still escaped detection in these hot months. Samples were then distilled when the air-temperature was about 60° F. and compared with similar results obtained by heating the condensing water and receiver artificially to 85° F. Here again, the latter on an average yielded less alcohol by about 2 per cent. So that the relation between high air-temperature and loss was doubly established. The practical effect of this new observation was that a whole series of spirits, which in June and July showed an average obscuration of only 0·3 per cent., in the winter months were actually found to have 2·0 to 3·0 per cent. of obscuration.

The most important inference to be drawn from these new facts is *the inevitable under-estimation of obscuration in Indian Custom Houses generally* where the temperature is much higher than here as a rule. The Collector of Customs, Calcutta, has kindly supplied me with records of obscurations obtained from 8 brands of imported spirits in the years 1897-98. In five of these the obscuration was determined in May *and, in every such case, the amount is markedly lower than that later found in the cooler months of the year.* This is clearly a laboratory result directly connected with the high temperature then prevalent. Moreover, the average obscuration obtained in the Calcutta Custom House appears to be something like 2 per cent. of the whole alcohol present whilst the average obscuration for the same class of spirits examined in Kasauli averages 4 per cent.

The Collector of Customs, Calcutta, informs me that the average gain to Revenue during the past five years, consequent on adopting obscuration tests, amounts to about Rs. 32,000 per annum. If 50 per cent. of the obscuration escapes detection, owing to this difficulty of air-temperature, it is obvious that a corresponding sum might be collected by overcoming the difficulty. I am inclined on my present data to think that at least an additional Rs. 15,000 per annum might be collected at Calcutta alone. I have now devised a method for obviating the difficulty above described completely and have proved its accuracy on a very large number of samples.

This case forms a striking instance of the necessity for conducting *spirit investigations* in as temperate a climate as possible. All spirit analysis centres round the temperature 60° F. Every sample has to be repeatedly brought to and maintained at that temperature and every degree that the atmospheric-temperature rises above that figure entails *not merely an increasing expenditure of time but a rapidly increasing and hitherto undetermined ratio of losses in alcohol and other constituents.* Such losses, though unimportant when spirit is handled in bulk (*e.g.*, in operations in bond), vitally affect the samples used in laboratory work, which to begin with are small and are, then, so to speak dissected in the course of analysis, thus enhancing the risk of loss. What applies to my present investigation applies equally to any laboratory that may be established in

This case incidentally proves danger of conducting experimental work of this kind under unsuitable climatic conditions.

the future for dealing critically with spirit questions from an excise point of view. Here, in Kasauli, work can be carried on under temperate conditions for nearly 9 months of the year and the knowledge obtained in Europe can be utilised without further special investigation. On the other hand, the accuracy of this, the only method for determining obscurations, was supposed to have been settled years ago for tropical temperatures. Hence it was the one part of my work that seemed to call for no special preliminary experiments. The conditions under which Colonel Warden worked in Calcutta prevented him from realising the whole truth. As a consequence, there has been a serious money loss to Government for many years.

Customs' laboratory operations must, of course, be carried out in the ports, but when a laboratory operation, wholly based on facts obtained in a temperate climate, has to be adopted in a tropical climate the effect of increased temperature should be carefully studied under temperate climatic conditions so that the necessary modifications can be ascertained. It is evident that a careful scrutiny of existing Indian Excise and Customs technical operations should be made and this work, as the above shows, cannot safely be carried out in any but a temperate climate. If this is neglected, faulty methods are relied on and losses of revenue—in many cases of a serious nature—must continue undetected.

CHAPTER IX.

Accuracy of Excise Hydrometers.

Data available.—The materials for this Chapter are based on—

(1) Correspondence with Excise Commissioners on the subject.

(2) Comparison of the actual hydrometer strengths of spirit samples, as determined on their arrival in this Laboratory, with the reputed strengths, *i.e.*, the hydrometer strength as determined by the distillery officer before despatch of the sample.

(3) Examination of 14 instruments forwarded to this Laboratory from different Provinces.

1. The letters received from Excise Commissioners appear to show that much attention is given to this subject. Glass Sikes's hydrometers are employed in many cases and often these instruments are supplied with certificates of accuracy.

Reputed strengths at distillery and actual strengths at Laboratory.

2. *Comparison of reputed strengths with the strength found by hydrometer on arrival of the samples in this Laboratory.*—Very few of the samples on arrival showed exactly the same apparent strength by hydrometer as that recorded at the distillery. The causes of difference may be summarised as—

(1) Large differences due to inaccuracy of the distillery hydrometer; or careless use of it.

(2) Small differences due to unavoidable inaccuracy in reading; and to slight losses by evaporation.

To eliminate (2), only discrepancies of 2 degrees proof either way (corresponding to about 1·2 degrees Sikes, or six sub-divisions on a stem graduated in fifths) have been considered in the following tabulation:—

Differences greater than 2 Degrees Proof.

I.—Spirits returned weaker than their real strength.

Spirits returned weaker than their real strength.

Laboratory No. of the sample.	No of degrees proof too low.	Remarks.
19	3·0	
20	2·7	Average proof degrees lost = 3·5
118	2·4	
159	2·9	Average proof strength of samples = 61% proof.
162	2·1	
180	2·7	
184	2·8	Average loss of alcohol to revenue = 5·8%
185	2·2	
187	2·4	
188	2·8	
223	2·5	
224	2·6	
243	2·3	
247	2·4	
248	4·0	
260	2·6	
273	3·1	
288	2·1	
324	2·1	
325	2·1	
346	2·4	
352	5·7	
355	4·2	
358	9·9	
361	2·1	
367	2·1	
368	8·6	
369	9·4	

Total 28 = 8%

Laboratory No. of the sample.	No. of degrees proof too low.	Remarks.
370	5·3	
371	5·8	Outstills (The figures are only given to show inaccuracies in hydrometers used in the districts).
31	9·5	
30	4·2	
35	5·4	
34	7·5	
33	5·4	
32	6·4	

In the above examples obscuration is not taken into account. These losses would be merely due to inaccurate determinations of the proof strength in the distilleries, that is to say, all these samples were found notably stronger in Alcohol than the distillery labels stated, despite the possibility of evaporation on their journey.

Too high strengths returned at distillery.

II.—The following are the cases in which the proof strength was returned too high in the distillery but some portion of the excess is accounted for by evaporation.

357	5·1	
5	2·7	Average proof degrees gained = 3·6
15	2·9	
21	3·6	Average proof strength of samples = 52·8%P. Average gain of alcohol = 6·8%.
25	2·2	
31	4·0	
67	2·5	
103	2·5	
139	8·1	
246	2·5	

Excise instruments examined here.

Thus the proof strength of 28 samples was returned too low, representing a loss to revenue of 5·8 per cent. of the alcohol in 8 per cent. of the samples examined. On the other hand 10 samples were returned too high, representing a gain to revenue of 6·8 per cent. of the alcohol in 3·5 per cent. of the samples examined. In other words Government appears to lose regularly the revenue on one per cent. of the alcohol in 22·6 per cent. of the samples examined, simply owing to the effects of faulty hydrometers or their inexact use. A further constant loss by obscuration arising from the natural acidity has already been dealt with.

It must be remembered that the above remarks only refer to the samples sent here. It is only reasonable to suppose that extra care was taken by the Excise Officers in making these readings, as they knew that their results would be checked on arrival here. So that the errors shown must be supposed to be chiefly instrumental rather than personal.

III. *Examination of instruments forwarded to this Laboratory.*—The following shows the results of tests made on the instruments sent here, including thermometers. It must be clearly understood that time only allowed of three observations being made on each hydrometer stem received. The thermometers were observed over nearly their whole scales.

Origin.	Description of hydrometer.	VARIATIONS OBSERVED IN DEGREES SIKES.			*Thermometer error.*
		a.	*b.*	*c.*	
Bengal	Brass, Sike's ...	*Nil*	−0·8	−0·4	1 degree too high.
	*Glass, Sikes ...	−2·0	−0·4	−1·2	Correct.
Eastern Bengal ...	Brass, direct reading ...	This leaks and is quite useless.			Correct.
Bombay	Glass, Sike's ...	*Nil*	*Nil*	*Nil*	None sent.
Madras	Glass, Casella, No. 15936	−1·9	−0·3	−0·3	Correct.
	Glass, Sike's, No. 13904	*Nil*	*Nil*	*Nil*	Correct.
	Glass, Sike's ...	−1·5	−0·7	−3·7	...
Central Provinces ...	Glass, Casella ...	+1·0	+0·6	−0·4	Correct.
	Brass, Sike's ...	*Nil*	+0·2	+1·2	1 degree too high.
	Glass „ ...	−0·9	+0·5	*Nil*	Correct.
Punjab	Glass direct reading ..	+1·0	+0·9	+1·1	None sent.
United Provinces ...	Brass, Sikes's ...	+0·3	−1·0	+0·7	1 degree too high.
	Glass „ ...	*Nil*	*Nil*	*Nil*	None sent.
	„ „ ...	*Nil*	*Nil*	*Nil*	None sent.

NOTE: + in the above columns means the stem-reading is too high thus + 0·2 degree means that a reading of 35 degrees Sikes is really 34·8 degrees Sikes.

— means the stem-reading is too low.

* Divided in single degrees, not in fifths of a degree.

NOTE.—The standard instruments in use in this Laboratory have been carefully calibrated by gravimetric determinations.

The glass Sikes's instruments have, as far as it has been possible to check them, proved the most accurate.

The thermometers were, on the whole, correct.

The very costly brass Sikes's hydrometers are well known to be quite unsuitable for use in India as they get lighter from corrosion by acid spirits.

Only selected instruments sent here.—The figures given in this Report do not, in my opinion, by any means adequately show the actual state of matters with regard to the accuracy or otherwise of hydrometers. Most of the instruments sent had probably been freshly issued from store and are mainly of the type employed by the higher grades of Excise Officers for testing hydrometers in use in their districts.

Inaccuracy of a large proportion of Excise hydrometers

The commoner varieties of hydrometers are frequently very inaccurate,† and the means for controlling them are in many Provinces certainly quite inadequate. In the course of my tour round Indian distilleries I found that some 40 per cent. of the hydrometers in use gave wrong readings some of them being many degrees out.

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†—"Saccharometers are seldom used. When they were found they were almost invariably incorrect, sometimes by as much as 20 degrees, or set to temperatures many degrees below the ordinary temperature of the wash dealt with. There is considerable loss through want of knowledge in this matter, and a very much purer spirit could be produced by a little more attention to the proper principles of fermentation."

* * * * * * *

"Some few of the distillers possess hydrometers but they are most of them incorrect."
Central Provinces' Excise Committee's Report, 1904, (page 40).

The thermometers supplied along with the hydrometers are liable to get out of order and should be periodically standardised.

Direct reading hydrometers not recommended for Excise use.

Direct reading hydrometers not recommended.—The direct reading hydrometers are not to be recommended for use. In a hot climate they necessitate cooling to the fixed temperature at which they are graduated and this is usually impossible where ice cannot be obtained. It always involves loss of time, and it is a physical operation of greater nicety than is commonly supposed. Any error made with such an instrument is much magnified by reason of the nature of the scale employed.

I have had no time or opportunity for the further consideration of means for supplying a universal pattern of a cheaper form of hydrometer. This is a matter which cannot be hurriedly decided on and which must, therefore, meanwhile stand over for future consideration.

Selection of suitable types of excise hydrometers.—The foregoing matter becomes all the more necessary in view of the fact that the question of fixed issue strengths will very shortly have to be decided and it would be useless to devise standard patterns until we know what fixed strengths are to be selected for issues.

Selection of suitable patterns of Excise hydrometers for use in India.

It will be sufficiently clear, however, that the State has every thing to gain by using (1) patterns of instruments really appropriate for Indian Excise purposes and not needlessly expensive as often at present; (2) that these must be issued in an accurate condition; (3) and periodically and systematically re-standardised by some much more efficient agency than is at present available in general for this purpose. Unless it is someone's special duty to attend to such matters it becomes a haphazard and badly performed duty and this means not only bad excise control but a very appreciable loss of revenue from the use of inaccurate instruments.

CHAPTER X.

INCREASE OF ALCOHOLIC STRENGTH IN SPIRITS ON KEEPING UNDER CERTAIN CONDITIONS.

Practical Excise difficulties on this score.

Excise officers in various parts of India have experienced a good deal of difficulty in conducting their proving-duties by the occurrence of an apparent *increase* of alcoholic strength when spirits are kept. The tabular summary of the papers submitted to the Excise Committee on this subject will sufficiently indicate the nature of the difficulties that have arisen in practice.

It will be observed that this subject has been under Excise consideration for some 14 years now and that there has been no practical outcome from such Excise observations as have been hitherto made in the Districts concerned. My present experiments have carried the matter a stage further but the time-limit for my work prevents their completion.

My work on the subject has, however, served to confirm the correctness of the chief facts observed by the Excise and hence to emphasize the practical importance of the matter.

Relative percentage rates of loss of alcohol and of water.

Relative percentage rates of loss of alcohol and of water.—In this chapter the question of "dryage," *i.e.*, gradual diminution in volume of alcoholic liquids when stored, is not considered. The point under consideration is the *relative percentage rates of loss of alcohol and of water* respectively from alcoholic liquors with the result, when these rates differ, that the apparent alcoholic strength of the liquid either increases or decreases. In temperate climates the alcohol escapes at a relatively greater speed than the water, so that a decrease in alcoholic strength is observed. It is perfectly clear, however, that the water escapes at the higher rate under certain conditions in India so that an increase of alcoholic strength ensues. The evidence sent to the Excise Committee and forwarded to me may be tabulated as follows:—

Tabular summary of the Excise Committee's papers.

Letter No.	Source.	Scope.	General Conclusions.
1	Collector of Khandesh ...	I. Observations of shop liquors	I. All show marked progressive increase (Malpur shop—27% increase).
		II. Experiments at Dhulia, 1891-92.	II. Steady progressive increase; slight initial decrease in 25 U. P. spirit.
2	Collector of Poona. Same person as 1.	I. Observations of shop liquors	I. Results irregular; often an increase.
		II. Experiment at Mandhwa distillery, 1893-4.	II. Steady progressive increase.
3	Collector of Bombay (from Dadar).	Experiments at Dadar Distillery, 1893-4.	(*a*) Spirits in wood, Decrease (non-progressive) in all but 2 out of 8 trials.
			(*b*) Spirits in jars: decrease (irregular).
4	Collector of Bombay (from Uran).	Experiments in Uran Distilleries (Mora), 1893-4.	(*a*) Spirits in wood. Decrease followed by a small progressive increase.
			(*b*) Spirits in jars, small and progressive decrease.
5	Collector of Bombay (from Panch Mahal).	Experiments at Godra distillery 1900.	(*a*) Spirits in wood. Decrease followed by progesive increase.
			(*b*) Spirits in jars. Non-progressive decrease.
6	Collector of Bombay (from Ahmedabad.)	Experiments at Ahmedabad distillery, 1900-01.	(*a*) Spirits in wood. Decrease followed by progressive increase.
			(*b*) Spirits in jars. Irregular decrease.
7	Collector, Khandesh ...	Same as in No. 1, but less marked.	......

The general result is that in some districts (generally dry and hot) there is a definite increase (usually preceded by an initial decrease) when the spirits are stored in wood; and the smaller the vessels, the greater is this increase.

On the other hand, when spirits are stored *in jars* a definite decrease, sometimes progressive, sometimes fluctuating, is observed.

Results of my experiments.

Results of my experiments.—The following is the bearing of certain experiments I have made here on the matter :—

I. Spirits when enclosed in a non-permeable vessel, together with an absorbent of both water and alcohol, undergo a *continuous progressive decrease in alcoholic strength*, *i.e.*, the percentage rate of loss is greater *for alcohol.*

II. Spirits when enclosed in non-permeable vessels through which a *slow current of dry air* is drawn over the surface of the liquid at first *shew a slight fluctuating decrease in alcohol*, *i.e.*, the percentage rate of loss is nearly the same for both alcohol and water.

This experiment could only be continued for 2 months (which, it may be noted, is the period during which initial decrease was noted in the cases reported in letters 4, 5, and 6 under reference) as otherwise the information would not have been in time for the Excise Committee's Report.

It must at present be considered inconclusive *as sufficient time was not available for its completion.*

III. Eight spirits set aside by me in cask for maturing experiments now show distinct increases in 7 out of 8 cases (*i.e.*, in 2 months) the conditions having been those which appear most to favour a change in this direction, *viz.*, very small wooden casks, partly filled and placed in a dry atmosphere.

The results are :—

Serial No.	Strength on 3rd March.	Strength on 1st May.	Difference in degrees proof per cent.
1	3·8 U.P.	3·5 U.P.	0·3 increase.
2	7·8 O.P.	8·45 O.P.	0·65 ,,
3	6·8 U.P.	6·45 U.P.	0·35 ,,
4	6·1 ,,	5·7 ,,	0·4 ,,
5	32·2 ,,	31·2 ,,	1·0 ,,
6	2·5 ,,	1·15 ,,	1·35 ,,
7	28·4 ,,	28·1 ,,	0·3 ,,
8	28·8 ,,	30·25 ,,	1·55 decrease.

IV. All other samples here are stored in *bottles and jars.* These always fall in strength: and no increase has been observed in any case examined here.

At present, I can only offer the following tentative explanation :—

(*a*) When spirits are stored in bottles, jars and such non-permeable vessels, the losses take place by ordinary evaporation when these vessels are opened. Alcohol being, as compared with water, the more volatile substance, its percentage rate of escape is greater, *i.e.*, the strength decreases.

(*b*) When spirits are stored in sound wooden vessels (*i.e.*, permeable vessels) the liquid as such does not escape through the walls, but the vapours of the contained liquids, slowly *diffuse* through. A well-known physical law shows that the speeds of diffusion of vapours vary inversely as the square root of their densities, according to which the relative speeds of diffusion of water and of alcohol-vapours would be as about 1·6 to 1.

Tentative explanations of discrepancies observed.

The air outside a cask may be considered "dry" to alcohol (*i.e.*, free of alcoholic vapour) everywhere, but, as regards water vapour, in some places in India it is almost quite dry and in others almost saturated. In very dry districts, then, it may be expected that the water vapour will, according to the above ratio, diffuse through the cask rather more than half as fast again as the alcohol vapour. So that alcohol would relatively accumulate and the spirits' strength would thus increase.

In very moist districts (where the air is nevertheless "dry" to alcohol) the speed of diffusion of alcohol-vapour would not be affected; but as regards water vapour the diffusion back into the cask from the saturated air outside counteracts the diffusion outwards and would make the resultant effect very small. So that the spirit strength should decrease, as practically only alcohol escapes.

This explanation would suffice for the observations on *casks*, and also would explain why the increase in small casks is greater than in large ones (small casks having a greater area for diffusion relative to the amount of liquor than large casks) but it would not explain the very high increases reported as observed when the spirits were *sealed in bottles*.*

The subject is one which it will be obvious is of much practical importance in many parts of India and which should be further thoroughly investigated with a view to laying down rules as soon as possible for the guidance of Excise officers.

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* *Vide* paragraph 4 of letter No. 1 sent to the Excise Committee by the Bombay Commissioner of Customs.

CHAPTER XI.

ON REDUCTION AND BLENDING WASTAGE, ETC.*

The Central Provinces' Excise Commissioner and Mr. Todhunter, when on Special Excise Duty in Central India, consulted me as to the possible methods for calculating the true amount of water required in reducing operations. This was with a view to avoiding the discrepancies which occur at present and to reconcile which certain tables in the Madras Excise Manual were prepared. The following is a discussion of the available means :—

Definitions of terms used.—For the sake of clearness, the meanings here attached to certain terms, may be first mentioned—

(1) *Reduction.*—The reducing of the strength of a spirit of known strength to a lower strength by the addition of *water only.*

(2) *Blending.*—The changing of the strength of a given spirit by blending with it another or other spirits of a different strength or strengths.

(3) *Shrinkage.*—The loss of bulk noticed when either reduction or blending is effected under the present faulty (incomplete) methods of calculation.

(4) *Wastage.*—The apparent loss of alcohol, which often occurs when the final quantity expressed in proof-gallons, is compared with the initial quantity in proof-gallons.

(5) *Strength-error.*—The difference in degrees-proof between the calculated and the observed strengths after reduction.

Thus the terms reduction-shrinkage, reduction-wastage, blending-shrinkage and blending-wastage explain themselves.

Whilst the operations of reduction and blending are directed to be kept strictly separate by the " Madras Excise Manual " (Appendix, page 42), some laxity is found in the use of the above terms and the meaning given them.

The above meanings will be retained in these notes.

General remarks.—It may be broadly stated that the quantity of water can be calculated, so that all the above numerical losses disappear except for small losses caused—

(1) by evaporation of alcohol, and

(2) by errors in gauging and proving.

REDUCTION OPERATIONS.

Present practice and formula employed.

Present practice adopted and " usual formula " employed.—At present the amount of water required to reduce, say, 160 gallons at 60 O.P., to 20 U.P., is calculated by the " usual formula " (Scarisbrick, page 143) which is simply a proportion-sum—

$$(1)\ \text{Final volume} = \text{initial volume} \times \frac{\text{initial proof-strength}}{\text{final proof-strength}}.$$

Whence (2) Final volume — initial volume = water to be added.

Thus in the given instance—

$$\frac{160 \times 160}{80} = 320 \text{ gallons at 20 U.P. (80 per cent. P.)} \quad \ldots \quad \ldots \quad (1)$$

$$\text{and } 320 - 160 \text{ gallons of water are required} \quad \ldots \quad \ldots \quad (2)$$

Fallacy involved.

Fallacy involved.—Even when this process is conducted at 60°F., shrinkage is always observed, because of the contraction in volume which takes place when alcohol and water are mixed.

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*The following extract illustrates well the state of excise control as regards wastages in many parts of India.

" The Officer in charge is ignorant of contraction, and had put down wastages due to this cause to a defect in the pump. He keeps a separate store of strong liquor, of which no account is taken, to correct them."

Central Provinces' Excise Committee's Report, 1904 (page 43).

" There is very little reduction with water. When there is, the distillers are ignorant of contraction. Blending wastages are therefore unknown. Dryage is written off variously at the option of the Deputy Commisioner, the Excise Inspector or the moharrir in different districts, and no strict account taken of it. In several places moharrirs avoid complications by simply deducting the amount of dryage ascertained from the outturn of the next day's distillation, thus vitiating the figures of outturn."

Central Provinces' Excise Committee's Report, 1904 (page 41).

Actually about 311 gallons only would result in the above case.

Shrinkage and strength-error.

Shrinkage and "strength-error."—To compensate for this shrinkage there is a "strength-error," *i.e.*, the spirit is proved to be slightly stronger than calculated, *viz.*, about 17·7 U. P. (82·3 per cent. P.). The proof-gallons however agree before and after the operation for 160 × 1·6 = 256 proof-gallons = 311 × ·823. (*Cf.* also "Madras Manual," page 281, lines 5—20, where the same point is made.)

Apparent wastage.

Apparent wastage and its cause.—When however the process is conducted at temperatures higher than 60° F. even the proof-gallons fail to agree; a certain loss of proof-gallons appears to take place. This loss, contraction or "wastage," is only *apparent*, because if the initial and final volumes are corrected to their *true volumes at 60°* F., the wastage disappears (except for errors of working). The explanation is that a strong spirit expands far more than a weak one in rising from 60° F., say, to 87° F., so that the apparent volume at 87° F., is further from the truth than is in the apparent volume of a weak spirit. Table D on page 399 of Brannt's "Distillation," gives a large number of reducing factors, for correction of volume to 60° F.

Desirability of avoiding it.—The Madras tables (Appendices, page 41) represent an effort to determine the amount of these apparent wastages at high temperatures. It would be much better to avoid them altogether by adding the correct amount of water (obtained by one of the following methods) in the first instance :—

I. General formula for calculating true amount of water.

General formula for calculating true amount of water.—I. The following general formulæ, expressed in the centesimal system, relate to reducing and blending operations :—

$$(1)\quad \frac{A}{100} = \frac{a + x\frac{a'}{100}}{\frac{100d + Xa'}{D}}$$

$$(2)\quad X = 100\ \frac{aD - Ad}{Ad' - a'D}$$

$$(3)\quad V = \frac{100d + Xd'}{D}$$

Where a and a' are the respective strengths (per cent. by volume) of two spirits to be blended and A the strength of the resulting mixture, and d, d' and D are the respective densities.

Also X is the volume of spirit a' to be blended with 100 volumes of a and V is the volume of the resulting mixture.

In reducing operations, $a' = 0$ and $d' = 1$

$$(4)\quad X = 100\ \frac{(aD - Ad)}{(\quad A\quad)}$$

therefore

$$(5)\quad V = \frac{100d \times X}{D}$$

These eliminate shrinkage, "strength-error" and wastage in reduction.—Now a, A and V can be given the values (transferred to the centesimal system) in the usual formula (*vide ante*) and X will then become the true amount of water required to dilute the given spirit to the bulk and strength given by the "usual formula." In other words there will be no "shrinkage" or "strength-error" or "wastage." A series of such values of X are given in Table F of Brannt's book, page 401.

Preparation of tables.

Preparation of Tables for reduction.—A table of true quantities of water in English terms of proof for all *reducing* operations at *60° F.*, might be compiled with these formulæ. For other temperatures the values a, D, etc., would require suitable modification.

To prepare a table of true quantities of water for the 46 operations mentioned in the Madras Table even at several fixed temperatures would be no great labour, but to compute tables for possible reductions at every practicable temperature would be a lengthy task.

II. Weight method.

By the "weight method" the gauger can find the true amount of water for himself at any temperature.—II. There is, however, a simple way of finding the true amount of water, the materials for which are given in Sikes's Tables. It is presumed that every gauger knows the procedure for finding the weight per gallon of any spirit at any temperature as described on pages 146 and 147 of Sikes (*cf.* gauging by weight " Madras Manual," page 290). To calculate the true amount of water the process is as follows (*vide* Keene, page 56) :—

(*a*) The bulk of the reduced spirit is calculated by the " usual formula."

(*b*) The weight is then ascertained from Sikes.

(*c*) The weight of the spirit to be reduced is likewise ascertained from Sikes.

(*d*) By subtracting (*c*) from (*b*) the weight of water is at once obtained. This amount divided by 10 is the number of gallons required.

Example at 60° F. Example : Reduce 160 gallons of spirit at 60 O.P. to 20 U.P.

(1) *When the temperature is* 60° *F.*

$\frac{160 \times 160}{80}$ = 320 gallons of spirit ... ... (*a*)

lbs.

320 gallons of 20 U.P. spirit weigh $320 \times 9{\cdot}420 = 3{,}014{\cdot}4$ ... (*b*)

160 „ of 60 O.P. „ $160 \times 8{\cdot}289 = 1{,}326{\cdot}2$ ... (*c*)

Difference $= 1{,}688{\cdot}2$ ... (*d*)

True quantity = 1,688·2 lbs. of water = 168·8 gallons.

(2) *When the temperature is 87° F.*

lbs.

320 gallons of 20 U.P. spirit weigh $320 \times 9{\cdot}305 = 2{,}977{\cdot}6$ ... (*b*)

160 „ of 60 O.P. „ $160 \times 8{\cdot}159 = 1{,}305{\cdot}4$ ... (*c*)

Difference $= 1{,}672{\cdot}2$ ... (*d*)

True quantity = 1,672·2 lbs. of water = 167·2 gallons.

So 168·8 gallons of water are required at 60° F. and only 167·2* gallons at 87° F.

III. Another method. *Another method of calculation by tables.*—III. Another method is available for consideration. Table E in Brannt's book (page 400) shows the actual content of alcohol and water in 100 volumes of any mixture of the two at 60° F. This serves to calculate the true amount of water required in any reduction-operation at 60° F. by a simple proportion-sum. This method was described in the " United States Internal Revenue Report of the National Academy of Sciences," 1866, and appears in the Manual then prepared (Duplais, page 691) expressed in the United States' proof terms.

Brannt's table shows that 100 volumes of—

(*a*) 60 per cent. (by volume) spirit contain 43·66 volumes of water.

(*b*) 40 per cent. (by volumes) spirit contain 63·406 volumes of water.

Whence $\frac{60 \times 63{\cdot}40}{40} = X$ is the bulk to which 100 volumes of (*a*) must be diluted to bring the proportion up to that in (*b*). But this bulk already contains the water present in (*a*), so that X—43·666 is the true amount of water required for this reduction operation at 60° F. This table might conveniently be arranged as a curve on squared paper where the ordinates would give the proof-strengths and the abscissæ, the corresponding amounts of water. It seems probable that similar curves for other temperatures might readily be plotted alongside by calculating only a few points for each curve. The curves, as such, might then be used by the officer, or complete tables might be prepared for the officers' use as in the above example.

Summary. *Summary as regards Reduction.*—All three methods give the same bulks and strengths as those given by the " usual (proportional) formula." Consequently the proof-gallons agree, without correction of apparent value to real volume at 60° F.

No. I method would appear to be impracticable except for a limited number of operations as in the Madras practice.

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* The 167·2 gallons would have the apparent volume of 167·7 gallons at 87°F. which is still more correct.

No. II only demands a simple application of knowledge already possessed by the officers.

No. III would more readily lend itself to the preparation of comprehensive tables, but it would entail teaching a new though simple method of calculation.

BLENDING OPERATIONS.

I. General formula.

General formulæ not suitable.—Inspection of the general formula (*vide ante*) shows that as *a* has now a definite value, *A* and *V* (*i.e.*, resulting strength and volume) cannot *both* be made to agree with the values given by the "usual formula." Consequently the inverse proportion between the volumes and proof-strength cannot be achieved and accordingly—

(1) the proof-gallons will agree at 60° F.,

(2) the proof-gallons disagree at, say, 87° F.

unless the apparent volumes are first corrected to their true volumes at 60° F. A small addition of water is needed to avoid (2) and the formula is not arranged for this.

Tables not feasible nor perhaps needed.—In any case, however, the number of combinations possible in blending is so great that tables could not be prepared for them, so that methods I and III may be dismissed. The errors in applying the "usual formula" (Scarisbrick, pages 143-144) are so small in practice that there appears to be no demand for such tables.

II. Weight method.

The weight method can be used.—The following applications of the weight method show that, because some contraction takes place, some water must be usually added to obtain the expected bulks and strengths and also what the amount is in the given case:—

Examples: (See Scarisbrick, top of page 144). Three hundred gallons of 35 O.P. spirits are to be reduced to 11 O.P. by addition of 35 U. P. spirit. How many gallons must be used?

$\frac{24 \times 300}{46} = \frac{7,200}{46} = 156{\cdot}5$ gallons of 35 U.P. spirit are required.

(1) *When the temperature is 60° F.*

$156{\cdot}5 \times 300 = 456{\cdot}5$ gallons of 11 O.P. spirit result ... (*a*)

lbs.

456·5 gallons of 11 O.P. spirit weigh $456{\cdot}5 \times 9{\cdot}055 = 4,133{\cdot}1$ ... (*b*)

300 " of 35 O.P. " $300{\cdot}0 \times 8{\cdot}716 = 2,614{\cdot}8$

156·5 " of 35 U.P. " $156{\cdot}5 \times 9{\cdot}560 = 1,496{\cdot}1$ ... (*c*)

Weight of spirit taken $= 4,110{\cdot}9$

but (*b*)—(*c*) $= 4,133{\cdot}1 - 4,110{\cdot}9 = 22{\cdot}2$ lbs. of water $= 2{\cdot}2$ gallons of water.

Therefore 2·2 gallons of water should also be added to really produce 456·5 gallons of 35 U.P. spirit.

(2) *When the temperature is 87° F.*

lbs.

456·5 gallons of 11 O.P. spirit weigh $456{\cdot}5 \times 8{\cdot}930 = 4,076{\cdot}5$ ... (*b*)

300 " of 35 O.P. " $300{\cdot}0 \times 8{\cdot}584 = 2,575{\cdot}2$

156·5 " of 35 U.P. " $156{\cdot}5 \times 9{\cdot}452 = 1,479{\cdot}2$ ... (*c*)

Weight of spirit taken $= 4,054{\cdot}4$

and (*b*)—(*c*) $= 22{\cdot}1$ lbs. of water or 2·2 gallons.

Therefore 2·2 gallons of water are required as in the operation at 60° F. The correction to apparent volume may be neglected. When this 2·2 gallons of water are added, the resulting bulk and strength agree with the quantities calculated from the "usual formula" and the proof-gallons also agree in both operations.

THE MADRAS TABLE.

This table (prepared from laboratory experiments presumably made in Madras) presents the following facts on the three first experiments recorded :—

(1) The ' strength-errors ' are chiefly *minus* not *plus* quantities.

(2) The proof-volumes when corrected to 60° F., do not tally, *i.e.*, there is a true wastage shown, not merely an apparent one (*vide* column (*b*) of each table).

Comparison of the weights of spirit-*plus*-water and resulting weak spirit (calculated from the recorded volumes and densities corresponding to the recorded strength) show in several cases an appreciable non-agreement. A direct experiment gave a possible explanation. 142·8 c.cs. of 40 O.P. spirit were measured from a very accurate burette into a weighed stoppered flask. The weight of this spirit was found to be about 0·5 gram less than its calculated weight, so that a serious loss of alcohol has resulted from passing it as a fine jet through the air, the temperature of which was 70° F. This loss is one that has no analogy in practical reducing operations. It is highly probable that the spirit was measured from a burette in the Madras experiments also, and the air temperature then was 87° F. The quantities employed in the experiments performed here (columns *c* & *e*) were controlled by direct weighments of their calculated amounts (volume × relative density at 87° F.). As a result, the apparent-wastage at 87° F. when the volumes (for comparison as proof c.cs.) are corrected to 60°F., in one case disappears, and in the other two becomes small *plus* quantities, *i.e.*, the proof c.cs. obtained were rather more than the possible amounts. This may be explained as follows :—

The factors to reduce the apparent volumes of the diluted spirits at 87° F. to true volumes at 60° F. were not available. Brix's Table in Brannt does not give them, presumably because they are nearly negligible. The reduction-factor used was that of water at 87° F. which was probably somewhat too small. Apparently 20 U. P. and 30 U. P. spirits require a small reduction factor (larger than that of water), whilst the dilatation of 60 U.P. spirit is almost identical with that of water alone.

Comparing the apparent wastages at 87° F. given by the Madras table columns (*a*) with those in column (*c*), it is observed that they are appreciably larger. Inasmuch as the wastages in (*c*) when corrected to 60° F. column (*d*) vanish, it may be concluded that the amounts shown in column (*b*) are really due to experimental error in the Madras results. For experiments I and II this amount is the same ; the reason is not quite clear why, in experiment III, the error is so great.

Column (*e*) shows the results obtained by adding the true amount of water and these without the tedious corrections of volume to 60° F. for comparison as proof-c.cs.

The shrinkage, strength-error and wastage disappear, except in Table II where there is a very small discrepancy. (0·1).

Without further experiments, especially to check III, it would be unwise to assert that the wastages in columns (*c*) are the real apparent wastages for these operations at temperature near 87° F (although the fact that they vanish in column (*d*) make them appear probable).

They *do* appear to indicate that the percentages in the Madras Table may be too high, *i.e.*, that the Madras Government at present allows an unnecessarily wide margin of wastage. This might be proved or disproved by examining the returns of some trustworthy officer.

Examination of Madras Table.

I.—Reduction of 40 O. P. spirit to 20 U. P. at 87° F. (before and after).

—	(*a*) Madras experiment at 87° F.	(*b*) Same corrected to 60° F.	(*c*) Madras experiments repeated at 87° F. at Kasauli.	(*d*) Same corrected to 60° F.	(*e*) Correct amount of water added at 87° F.
*6. Spirit taken (apparent c.cs.) ...	285·7	281·5	285·7	281·5	285·7
7. Equivalent in proof c.cs.	400·0	394·1	400·0	394·1	400·0
8. Water added (apparent c.cs.) ...	214·3	214·3	214·3	214·3	222·9
11. Strength of mixture (degrees U. P.) ... " Strength-error "	20·2 U.P. —0·2	20·2 U.P. —0·2	19·5 U.P. +0·5	19·5 U.P. +0·5	20·0 U.P. Nil.
12. " Shrinkage " per calculated 500 c.cs. ...	9·3	9·3	8·3	8·3	Nil.
13. Volume obtained in c.cs.	490·7	489·0	491·7	490·1	500·0
14. Spirit measured in proof c.cs. ...	391·6	390·2	395·8	394·5	400·0
16. " Wastage "—proof per cent. ...	2·1 Apparent.	1·0 Real.	1·0 Apparent.	+0·1 Real.	Nil. Apparent and real.

* *Note.*—These vertical numbers correspond to the column numbers in the horizontal line on the Madras Table.

Examination of Madras Table.

II.—Reduction of 40 O.P. spirit to 30 U. P. at 87° F. (before and after).

—	(*a*) Madras experiment at 87° F.	(*b*) Same corrected to 60° F.	(*c*) Madras experiment repeated at 87° F. at Kasauli.	(*d*) Same corrected to 60° F.	(*e*) Correct amount of water added at 87° F.
*6. Spirit taken (apparent c.cs.) ...	250·0	246·3	250·0	246·3	250·0
7. Equivalent in proof c.cs.	350·0	344·9	350·0	344·9	350·0
8. Water added (apparent c.cs.) ...	250·0	250·0	250·0	250·0	258·3
11. Strength of mixture (degrees U. P.) ... "Strength-error "	30·9 U.P. —0·9	30·9 U. P. —0·9	29·6 U. P. +0·4	29·6 U.P. +0·4	†30·1 U.P. −0·1
12. " Shrinkage " per calculated 500 c.cs....	9·5	9·5	8·0	8·0	Nil.
13. Volume obtained in c.cs.	490·5	488·8	492·0	490·3	500·0
14. Spirit measured in proof c.cs. ...	338·9	337·8	346·4	345·7	349·5
16. " Wastage "—proof per cent. ...	3·2 Apparent.	2·0 Real.	1·0 Apparent.	+0·2 Real.	0·1 Apparent and real.

* *Note*—These vertical numbers correspond to the column numbers in the horizontal line on the Madras Table.

† At 70° F., 73·6° Sikes = 30·1 U. P. } The observation was *barely* 73·6° S. Sikes gives the true strength at 60° F.
,, 73·4° ,, = 29·6 U. P. } whatever the temperature of observation.

EXAMINATION OF MADRAS TABLE.

III.—Reduction of 40 O. P. spirit to 60 U. P. at 87° F. (before and after).

—	(*a*) Madras experiment at 87° F.	(*b*) Same corrected to 60° F.	(*c*) Madras experiment repeated at 87° F. at Kasauli.	(*d*) Same corrected to 60° F.	(*e*) Correct amount of water added at 87° F.
*6. Spirit taken (apparent c.cs.) ...	142·8	140·7	142·8	140·7	142·8
7. Equivalent in proof c.cs.	199·9	197·0	199·9	197·0	200·0
8. Water added (apparent c.cs.) ...	357·2	357·2	357·2	357·2	362·9
11. Strength of mixture (degrees U. P.) ...	26·1 U.P.	62·1 U.P.	60·0 U.P.	60·0 U.P.	60·0 U.P.
"Strength-error"	— 2·1	—2·1	Nil.	Nil.	Nil.
12. Volume obtained in c.cs.	493·6	491·9	494·3	592·6	500·0
13. "Shrinkage" per calculated 500 c.cs. ...	6·4	6·4	5·7	5·7	Nil.
14 Spirit measured in proof c.cs. ...	187·1	186·4	197·7	197·0	200·0
16. "Wastage"—proof per cent. ...	6·4	5·4	1·1	Nil	Nil.
	Apparent.	Real.	Apparent.	Real.	Apparent and real.

**Note*—These vertical numbers correspond to the column-numbers in the horizontal line on the Madras Table.

CHAPTER XII.

DYEING OF DUTY-PAID SPIRIT.

If it is considered necessary for the protection of the Excise revenue to "ear-mark" liquor that has paid duty, it would appear that the simplest and most controllable way of doing so would be by the addition of some chemical substance which, while in no way interfering with any of the characters of the liquor (*e.g.*, taste, odour, action, etc.), would be identifiable by the exciseman with ease and certainty.

Requirements for spirit dyes.

Such a substance may be one that imparts to the liquor a permanent and more or less distinctive colour—which must also be attractive from the consumer's point of view—and which can be further identified with absolute certainty by the addition to it of a few drops of a chemical reagent which would in turn produce a colour that would be entirely characteristic and that could not therefore be imitated in any way for illicit purposes.

There is another alternative method. A chemical substance—similarly inert in its effects on the liquor's quality—could be added to it, but without colouring it in any way. But when a small amount of the liquor was tested by the exciseman (by adding a few drops of a chemical reagent to it) a distinctive colour would be instantly produced and this colour would be only produced by the interaction of these two substances.

The following precautions would be necessary to ensure the success of the procedure :—

(*a*) The substance added to the liquor would have to be one which did not deteriorate on keeping in any way, either alone or when added to the liquor.

(*b*) It must be non-poisonous, odourless, tasteless, cheap and absolutely distinctive. And, if it is considered necessary that it should impart from the first a colour to the liquor, then the colour must be an attractive one to the consumer.

(*c*) In order to control issues and to prevent sale of the dye to illicit dealers, etc., by a dishonest excise subordinate it should be added in a fixed minimal quantity to the liquor. Hence by comparing the amount used with the number of gallons of liquor dyed and issued a tally could be kept.

(*d*) On the following page there is quoted an instance of how *not* to conduct such an operation. To prevent similar occurrences it is absolutely essential that the dye and reagent for identifying it be issued by some central scientific agency where its quality and suitability can be certified and where a control on all issues can be effectually maintained.

(*e*) It is obviously necessary that the nature of the dye and reagent be known only to the scientific issuing officer, who would be held responsible for the correct quality and issues of the same to Provincial Excise Departments. If this be not done, the nature of these substances would become known and the object in view would, of course, be defeated.

(*f*) The dye would be selected so as to defy analysis so that its nature could not be ascertained for illicit purposes.

(*g*) In order to effectually prevent mistakes by excisemen as regards the identity of the colour to be produced on adding the reagent to the dyed liquor, a standard coloured glass slip representing the required colour might be issued to every testing officer.

Possible objection to use of dyes.

It has been (theoretically) objected in one instance that the dyeing of liquor might cause a plague (or other) scare. It has been found that this is practically a negligible point, as the experience of Bengal shows (see page 12, paragraph 4, of my Preliminary Report). It is a moot point whether it would be better to use a substance which would colour the liquor or one that would only cause the distinctive colour on addition by the exciseman of the special chemical reagent. I personally incline to the latter course.

It is difficult to see how the addition of a substance that causes no perceptible change in the liquor (other than striking a colour only on the addition of an excise reagent) could cause scares, as the consumers would be unconscious of its presence. Even if they knew of such addition they would find very speedily that nothing untoward happened, and the true explanation would soon come to be accepted.

One great advantage would be that convictions for possession of illicit liquor could be obtained without difficulty in cases where undyed or illicit dyed liquor was seized. And, for legal purposes, a confirmatory report from some central scientific agency could be easily arranged for if necessary.

Control of issues of dye.

Control of the amount of dye issued to Excisemen.—To get over the difficulties of wastage if the dye were issued in the form of a powder, I would suggest issue in the form of tablets, each containing a unit of dye. These tablets could be turned out in large amount by means of a "tabloid-machine" which can easily be worked at a central agency such as has been proposed. In this way a fixed number of tablets would be issued in cylindrical tubes slightly wider than the tablet so that the latter could not get broken up in transit. The Exciseman would add one tablet to, say, each gallon of liquor issued and by comparison of the liquor-issues with the number of tablets used a complete check could be exercised.

Admixture of dyed and undyed liquors.

Admixture of undyed Liquor with dyed.—This difficulty might be overcome by issuing tablets of dye, each of which would dye only, say, one gallon of liquor. If the liquor was illicitly diluted further then the dye would not respond to the excise test and in this way would come to be treated as illicitly made or unlawfully diluted. This would thus act doubly as a simple and rapid check on the licitness of the liquor and as a proof of its non-dilution, or otherwise.

Under a proper system of liquor-control dilution by the vendor should not be permitted. The only permissible dilutions should be—

(*a*) in the bonded warehouse before issue when the liquor from the distillery would be proved, diluted to a fixed strength and finally "dyed" before issue; or

(*b*) by the consumer after purchase from the retail-vendor. If the Indian retailer is allowed to dilute, it opens the way to all manner of abuses.

Use of dye by untrained men.

The use of the dye by untrained men.—The dyed liquor alone would respond to the addition of the test-reagent. A distinct colour would result with the licit liquor, but no change would occur in the case of the illicit liquor. Even the most ignorant and untrained man would be able to say whether this marked colour was produced or not on adding the reagent. If no colour resulted he could detain the suspected liquor pending receipt of further orders from the nearest Excise officer to whom a small quantity of the liquor in a sealed bottle could be sent for confirmatory test.

Instance of the danger of issue by a non-expert agency.

Some years ago, at the request of the Bengal Excise Department, I devised a dye for the identification of distillery spirit. This dye possessed all the characters requisite for its use as such. The name and description of the dye (along with a sample) were confidentially communicated by me to the Bengal Commissioner of Excise and I suggested that it should be procured, confidentially, through the India Office and distributed to distillers without any indication as to its real nature. I have already described at pages 11-12 of my Preliminary Note to Government what effect was given to these suggestions; and in no case, up to the present, has the dye I recommended been used, but instead many different dyes (which were supplied as being the dye devised by me) have been in use—naturally with very unsatisfactory results. At the end of this chapter is appended some correspondence on the subject that will serve to illustrate this point. This case (which is by no means an isolated instance) serves to illustrate the present lack of proper control in even so simple a matter as this and the urgent necessity which exists for placing all such matters in the hands of some proper controlling expert agency, as in other countries.

The dye devised by me for the Bengal Excise Department is one which (solely through neglect of my cautions) is now useless and should be abandoned, as I found last year in several Bengal distilleries that the tins of dye sent out from home had the name of a somewhat similar dye printed on each tin.

Unless, then, the recommendations be adopted as to issue from (preferably) one centre, after testing the quality of the dye, it would be better that no attempt to dye liquors should be made. On the other hand, the control of the whole operation becomes so absolutely simple and sure, if the precautions I have mentioned are taken, that no difficulty could arise. It is merely a question of proper method and of due care as against the opposite condition of affairs.

Outstill liquors.

Outstill liquors.—It would appear to be inadvisable and unnecessary to dye such liquors in view of the Government of India's declared policy of restricting the number of outstills as far as possible, and, further, having regard to the conditions under which the outstill system is worked. In any case outstill liquor could be distinguished from distillery liquor by its failure to respond to the latter's distinctive colour test. The same would of course, apply to illicit liquor, but it is a question whether it be desirable or not to protect outstill liquor against illicit liquor by any such means. The outstill owner is likely to protect himself from competition with an illicit supply by other means.

Differential dyeing.

13. *Differential dyeing.*—The Punjab Excise Commissioner has suggested to me that it might be advantageous to extend the dyeing system even further and to dye distinctively the liquor of each distillery area. This would be easier in the case of the Punjab than in any other Province, as its distilleries are only five in number and are nearly all worked on modern lines, chiefly by European managers. But I fear it would be impossible elsewhere and for this reason. There is, to the best of my knowledge at present, a comparatively limited number of substances available as spirit dyes which fulfil all the required conditions and, in fact, there would not be enough to supply the larger number of distilleries at present existing in India.

Work of devising dyes must be very carefully and deliberately carried out.

Devising of suitable dyes.—It should be noted that the work connected with the subject of devising and testing these dyes would occupy many months, as their permanency under various conditions (casking, bottling, keeping, various temperatures, &c.) would require to be thoroughly worked out and the experiments necessary to ensure all the above-enumerated conditions for success would have to be very carefully conducted. It is not unlikely that it might be necessary to devise some new combination more suitable for our purpose than any at present existent, so that any attempts to identify its nature by chemical analysis might be frustrated.

It is proposed to devise a similar method for the protection of excise opium and the experiments connected with this might be conducted alongside of those above recommended.

Appendix to Chapter 12.

No. 1129-E., dated Writers' Buildings, Calcutta, the 18th December 1905.

From—The Commissioner of Excise and Salt, Bengal,

To—MAJOR C. H. BEDFORD, I.M.S., on Special Duty, Finance Department, Government of India, Kasauli.

I HAVE the honour to forward herewith a sample of the dye recommended by you for colouring distillery liquor in this province, and to state that the consumers object to the new dye on account of the repulsive appearance of the spirit when mixed with it in an earthen—the common—vessel of the country, or when viewed from above. I request the favour of your kindly informing me what, if anything, can be done to prevent the new dye giving the liquor a repulsive appearance when poured into earthen cups. The sales of spirits have fallen considerably on account of the dye and the loss of revenue to Government is in places very marked.

No. 645, dated Country Liquors' Investigation Laboratory, Kasauli, the 21st December 1905.

From—MAJOR C. H. BEDFORD, I.M.S., on Special Duty, Finance Department, Government of India,

To—The Commissioner of Excise, Bengal, Calcutta.

IN reply to your No. 1129-E., dated the 18th instant, I have the honour to inform you that the contents of the bottle of dye sent by you therewith differ from the dye recommended by me for use in Bengal distilleries.

2. I must explain that there are a number of dyes of the same name, but which are distinguished from each other by the addition of letters, numbers, etc. These dyes differ much each from the other, as you are already aware (see my letter of 5th August last).

3. In any case, the nature of the dye recommended by me must now be well-known to persons interested in its identity, as the first issues were sent out in tins bearing the name of a dye of the same class, though of different properties. Its use should therefore be discontinued, as its nature is no longer a secret. If a dye which will impart a colour is still required, I can supply it after fresh investigations, as it is a difficult matter to obtain a dye with all the necessary requirements.

4. Apart from these circumstances, I strongly advise the Bengal Excise Department to discontinue the use of dyes for spirits until it can be arranged to have these dyes first identified and issued through some single expert agency. I have throughout urged the necessity for this and have lately again impressed this on the Finance Department, Government of India, and on the Excise Committee, and in this connection I would refer you to pages 12, 13 and 15 of my Preliminary Report to the Finance Department, Government of India, dated 15th July last.

5. I was asked to supply a dye having certain specified qualities for use in Bengal distilleries and the dye I suggested was strictly in conformity with those requirements. But I consider that the best way to distinguish distillery liquor is to add in fixed proportion to it a substance of entirely neutral qualities which will not even colour the liquor and whose presence in the liquor will only be revealed by the production of a characteristic colour on addition of the special reagent by the Excise Officer.

6. The nature of this substance should be known only to the expert who is responsible for its being of the required nature and quality and through whom it should be issued to the Excise authorities. Unless this is done, there can be no guarantee of secrecy, identity or quality, and mistakes are bound to continue to occur, for the tradespeople who supply such articles can certainly not be relied upon to guarantee their identity and quality, as ample previous experience in such matters shows.

7. If the simple precautions I have proposed are followed, the identification of licit liquor by the means suggested becomes a very easy and thoroughly trustworthy method of control.

No. 469-E., dated Calcutta, the 20th July 1905.

From—The Commissioner of Excise and Salt, Bengal,

To—MAJOR C. H. BEDFORD, I.M.S., Liquor Investigation Laboratory, Kasauli, Punjab.

I HAVE the honour to send, herewith, a packet of the dye for colouring distillery liquor in this Province and three other packets of dye sold in the Calcutta market for colouring cotton fabrics, and to request that you will kindly analyse them and report: (1) whether samples Nos. II, III, and IV bear any affinity with sample No. 1; (2) whether they can be substituted for sample No. I; and (3) whether the test applied in the case of sample No. I will be applicable to the other samples.

No. 351, dated Kasauli, the 5th August 1905.

From—MAJOR C. H. BEDFORD, I.M.S., On Special Duty, Finance Department, Government of India,

To—The Commissioner of Excise, Bengal.

In reply to your No. 469-E., dated the 20th July last, I have the honour to state that—

(1) Sample No. I is quite distinct from samples Nos. II, III and IV, and that it could not be mistaken for any of the others if the prescribed test with silver nitrate is carried out.

(2) Nos. II, III and IV could not be successfully substituted for No. I, if the most ordinary care is exercised by the subordinate Excise officers concerned.

(3) The prescribed test (with silver nitrate) responds differently with each sample. Only No. I yields a rose-red colour; No. II gives a light pink colour; No. III a dark cherry red; and No. IV a yellowish red. If in any case of doubt the precaution be taken which is set forth in footnote (*c*) of your Circular No. 19-E—C.L., dated the 24th February 1904, no difficulty in distinguishing these dyes can occur.

(4) I have recently analysed dyed samples from the following Bengal distilleries, *viz.*:—

Balasore.
Burdwan.
Bhagalpur.
Monghyr.
Gaya.

In every case, the spirits are dyed with a dye which is quite different to that suggested by me and which does not respond in any way to the prescribed test with silver nitrate.

No. 15, dated Kasauli, the 5th January 1906.

From—MAJOR C. H. BEDFORD, I.M.S., on Special Duty, Finance Department, Government of India,

To—The Commissioner of Excise, Bengal.

In continuation of my No. 645, dated the 21st ultimo, I have the honour to report as follows on five samples of liquor received from Patna Distillery on 3rd January 1906.

No. I Sample.—Gur spirit, 65·2 U.P., and described on label as of "Orange red colour."

On examination here:—

(*a*) In earthen vessel, repulsive opaque pinkish colour when viewed from above.

(*b*) In glass vessel, opaque orange pink when viewed from above; clear pink colour when held up to light.

(*c*) With silver nitrate test, *no change.*

No. 2 Sample.—Wash from which No. I was prepared. Not dyed.

No. 3 Sample.—*Gur* spirit, 65·2 U.P., said to be dyed with the "new dye" and to be of a "brown or green colour."

On examination here—

(*a*) In earthen vessel, orange pinkish colour.

(*b*) In glass vessel, clear pink colour.

(*c*) With silver nitrate test, *no change.*

No. 4 Sample.—*Gur* spirit, 65·2 U.P., said to be dyed with the "old dye" and to be of an orange red colour.

On examination here—

(*a*) In earthen vessel, deep orange pink colour.

(*b*) In glass vessel, rose pink.

(*c*) With silver nitrate test, *no change.*

No. 5 Sample.—Wash from which Nos. 3 and 4 were distilled ; not dyed.

2. It will be seen from the above that, in no case, have these spirits been dyed with the dye recommended by me for use in Bengal distilleries.

CHAPTER XIII.

CHANGES IN SPIRITS OF VARIOUS TYPES ON KEEPING AND CASKING.

Maturation in various types of spirit.

Comparison of maturation in various types of India spirits.—To ascertain, so far as possible in the short time at my disposal, to what extent the constituents of spirits alter in amount by keeping, I selected samples of various kinds of spirits made in India, *viz.*, Indo-European rum; cocoanut spirit; *shira*; *mahua*; date and *gur*; *gur* and *mahua*; *shira* (made in a so-called "Bombay still"); and *mahua* (similarly distilled). These were specially chosen with reference to the proportions of by-products previously found on analysis and I procured eight quite newly-made oak, one-gallon kegs in each of which one of the above-mentioned spirits was stored for 3½ months. The spirits immediately before casking were again analysed; and later, on the completion of the period of casking, they were again completely analysed.

These spirits can thus be compared—

(*a*) On arrival from the distillery where they had been (so far as is known) freshly distilled;

(*b*) After remaining in stone jar or bottles from four to six months and before casking;

(*c*) After being casked for 3½ months.

I am very far from wishing to attach any undue weight to the results of so few analyses (all that have been possible owing to the limitations as regards time) and which had to be conducted on so small a scale. The results seem, however, of sufficient interest to reproduce here. In the following table I have contrasted the analyses of these eight samples:

TABLE A.

Results.

—	—	Apparent strength alcohol per cent. by volume.	True alcoholic strength per cent. by volume.	Obscuration per cent.	In Milligrams per 100 c.c. or parts per 100,000, approximately, of absolute alcohol.				
					Acidity.	Aldehydes.	Furfurol.	Fusel oil.	Ethers.
I	*a.* Indo-European rum London Proof ...	57·7	59·9	3·7	13·0	70·6	0·8	198 3	70.5
	b. Do. do.	57·2	61·8	7·4	72·8	46·8	*Nil.*	149·5	71·2
	c. Do. do.	54·9	57·6	4·7	36·5	23·4	*Nil.*	294·8	61·1
II	*a.* Cocoanut toddy 11·5—O.P.	62·6	63·4	1·3	315·1	14·3	1·7	39·6	477·4
	b. Do. do.	63·5	64·5	1·5	74·4	13·0	1·2	156 9	266·0
	c. Do. do.	61·5	65·1	5·5	33·2	Trace.	*Nil.*	118·9	371·7
III	*a.* *Shira*—1·8 O.P. ...	58·2	58·6	0·7	69·1	10·1	2·5	32·4	201·2
	b. Do. ...	57·4	58·8	2·4	86·7	12·1	2·2	208·0	224·4
	c. Do. ...	53·2	55·0	3·2	92·7	Trace.	1·1	128 0	184·0
IV	*a.* *Mahua*—0·9 O.P. ...	56·8	58·0	2·1	226·7	41·0	6·0	45·8	365·5
	b. Do. ...	56·7	59·2	4·2	263·5	39·2	5·5	178·3	267·5
	c. Do. ...	53·6	54·0	0·7	222·2	Trace.	1·5	177·6	260·7
V	*a.* Date *gur*—30 U.P. ...	39·4	40·4	1·5	504·9	24·0	4·7	112·9	143·5
	b. Do. ...	40·2	42·4	5·2	452 8	23·8	3·0	263·7	145·3
	c. Do. ...	38·7	41·4	6·5	543·4	Trace.	1·4	367·6	255·0
VI	*a* *Gur* and *Mahua*—London Proof	57·4	57·5	0·2	103·3	24·0	12·4	72·7	313·2
	b. Do. do.	57·1	59·4	4·0	116·1	22·0	7·2	282·9	288·8
	c. Do. do.	55·6	56·8	2·1	211·2	17·1	2·8	274·1	255·6
VII	*a.* *Shira*—25·2 U.P. ...	43·9	44·0	0·2	348·7	10·9	4·0	52·0	144·1
	b. Do. ...	43·2	45·6	5·2	388·1	2·4	3·5	260·5	144·7
	c. Do. ...	40·8	40·8	*Nil.*	500·0	Trace.	1·7	295·6	161·7
VIII	*a.* *Mahua*—25·4 U.P. (Bombay still)	43·1	43·2	0·2	439.4	24·5	11·3	122·5	334·0
	b. Do. do.	42·9	43·8	2·0	486·3	31·3	6·6	253·5	381·7
	c. Do. do.	40·6	43·0	5·6	593·0	15·3	Trace.	392·8	317·2

NOTE.—

a = Analysed June-July 1905.
b = Analysed before casking on 15th November 1905.
c = Analysed after casking on 2nd March 1906.

TABLE B.—*Details the Observed Changes in the Spirits on keeping.*

I. INDO-EUROPEAN RUM—

Acidity—first increased and then diminished but not nearly to amount originally found.

Aldehydes—steadily diminished.

Furfural—disappeared.

Fusel oils—first diminished and then very markedly increased.

Ethers—steadily diminished.

II. COCOANUT TODDY—

Acidity—steadily diminished.

Aldehydes—practically disappeared.

Furfural—practically disappeared.

Fusel oils now—increased but are now diminishing.

Ethers—first diminished greatly, then increased but still below the original amount.

III. *Shira*—

Acidity—increased.

Aldehydes—practically all disappeared.

Furfural—decreased steadily.

Fusel oils—increased but are now decreasing.

Ethers—after slight increase are now less than at first.

IV. *Mahua*—

Acidity—after slight increase has disminished below original amount.

Aldehydes—practically disappeared.

Furfural—diminishing rapidly and progressively.

Fusel oil—increased very markedly (almost negligible difference between (*b*) and (*c*)).

Ethers—diminished markedly.

V. DATE *Gur*—

Acidity—diminished but has now increased somewhat beyond original amount.

Aldehydes—practically disappeared.

Furfural—much diminished.

Fusel oil—steadily increased.

Ethers—steadily increased.

VI. *Gur* AND *Mahua*—

Acidity—gradually increased and now is more than twice the original amount.

Aldehydes—steadily diminishing.

Furfural—steadily diminishing.

Fusel oil—increased largely but now diminishing but still much above the original amount.

Ethers—diminishing.

VII. *Shira* (BOMBAY STILL)—

Acidity—slowly increase.

Aldehydes—disappeared.

Furfural—steady and marked diminution.

Fusel oil—steady increase.

Ethers—steady increase.

VIII. *Mahua* (BOMBAY STILL)—

Acidity—steady increase.

Aldehydes—steady diminution.

Furfural—disappeared practically.

Fusel oil—steady and marked increase.

Ethers—after some increase now less than at first.

TABLE C *shows the same approximately* : + *or* − *Terms.*

+ = Increase in amount. — = Decrease in amount.

By-products.	Sample.							
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.
Acidity ...	+ then. —	—	+	+ then. —	— then. +	+	+	+
Aldehydes ...	—	—	—	—	—	—	—	—
Furfural ...	—	—	—	—	—	—	—	—
Fusel oil ...	— then. +	+ then. —	+ now. —	+	+	+ now. —	+	+
Ethers	—	—	—	—	+	—	+	—

CONCLUSIONS.

Alcoholic strength.

Alcoholic strength.—With one exception there has been a decrease in *apparent strength* between the first two observations (*a*) and (*b*) in each case. This is in accordance with previous experience as to storage in bottle. There is also a definite loss in all cases as between (*b*) and (*c*), *i.e.*, when casked. The latter is chiefly accounted for by the fact that the casks had been previously immersed in water (to make the wood swell and prevent leakage), with consequent dilution of the spirit. This was unavoidable under the circumstances. The fact, however, quite prevents the drawing of any conclusions at this stage from these experiments on the question of the alleged increase of alcoholic strength while in cask, which subject is dealt with in Chapter 10.

As regards the true alcoholic strength.—It will be noticed that there is a distinct increase between (*a*) and (*b*). The (*a*) determinations were made in June and the (*b*) in November and the spirits were meanwhile in bottle. It should not be imagined that this increase *actually* took place. This would be contrary to experience which shows that bottled spirits lose alcoholic strength and to the evidence of the hydrometer figures already referred to. The explanation of this matter is also given in Chapter 10.

Acidity.

Acidity.—In two cases there was a diminution followed by an increase; and in one case the opposite condition. In one case there was a diminution in acidity; and in four cases an increase. These variations which at first sight might seem conflicting are explainable by the varying conditions of manufacture and by the resulting degrees of acidity (*i.e.*, originally present in the spirits and also derived from the cask); absorption by the cask; and degree of alcoholic strength.

Aldehydes and Furfural.—In every case these markedly diminished by keeping and in several instances have practically quite disappeared. This result is of much interest as showing the effect of maturing in removing what are perhaps the most objectionable of all the by-products of spirits.

Aldehydes, etc.

Mr. Allen, in his evidence before the Playfair Commission, stated that furfural does not diminish in amount even in spirits which had been kept for twelve years. This statement must probably have been based on a single analysis. In any case, my results on this point confute it. Eighty-two samples of all varieties of spirits were re-examined after a period of three months in bottle in order to ascertain whether the furfural present had lessened in amount by keeping. Of these, 66 samples were found to have lost on an average 31·2 per cent. of their furfural.

Eleven remained unchanged.

In five cases there were apparent increases but in three of these the amount was insignificant and within the limit of experimental error. So that there can be no doubt that, in general, the furfural in spirits tends markedly to lessen in amount by keeping.

Fusel Oil.

Fusel oil.—It used to be supposed that one of the great advantages of maturing was the diminution brought about in the amount of fusel oil. This point has been much disputed. For instance, Dr. Bell, C.B., F.R.S., formerly Director of the Government Laboratories, London, in his evidence before Lord Playfair's Commission on British and Foreign spirits, stated (referring chiefly to whiskeys) that fusel oil and ethers remain stationary in amount after casking or bottling. This may possibly be true in the case of some whiskeys. Mr. Allen, on the other hand, stated that fusel oil diminishes on keeping and that ethers increase.

My results, however, show that in five cases fusel oil has markedly increased in amount by keeping and that in the other three cases after an initial increase in amount there followed some diminution.

Ethers.

Ethers.—In six cases, these markedly lessened in amount and in the other two cases increased.

To sum up, the general effect of even so comparatively short a maturation* as in the above experiments is in the direction of improvement of quality. This result accords with all experience on the point. It is matter of popular belief that matured spirits possess great advantages over unmatured. Matured spirits are found to be: milder in taste; improved in bouquet; less irritating to the mucous membranes with which they are brought in contact; and further they are said to cause in general less excitement, or serious or disagreeable after-effects. It has been stated that *mahua* spirits mature specially rapidly. The results now obtained, so far as they go, do not appear to support this impression in any special degree, as there is apparently no marked difference in this respect between the *mahua* and other kinds of spirits examined.

A fourth and final series of analyses was conducted on these eight samples on 23rd May, 1906, *i.e.*, about 2½ months after the previous analyses.

It was found, however, that the amount of spirit remaining in the casks was dangerously small in relation to the air-space and absorbing-surface of the cask so that I decided that it would be better to altogether leave out of account the results obtained. For, so far as they go, they are indicative more of excessive oxidation than of genuine maturation. One point of interest elicited was the increase of alcoholic strength of spirits when casked in this dry atmosphere, thus bearing out the previous observations referred to in Chapter X.

The practical question remains :—

Conclusions.

Would compulsory bonding be worth the great cost and trouble involved? In India the native consumer in general does not linger over the bouquet of his spirits, as does the *gourmet* elsewhere. He usually drinks with grosser ends in view so that he would scarcely sympathise with any policy designed to heighten the æsthetic qualities of his drink at the expense of greatly enhancing its cost as bonding inevitably must do. So, from the point of commercial quality and in view of the comparative cheapness of Indian spirits, I do not think that bonding would be worth while. And from the aspect of hygienic quality, while there is no doubt something to be said yet when we consider how apparently negligible is the action of the relatively small proportions of by-products present in nearly all spirits, the commonsense view of the question would appear to be that bonding for purposes of improving the hygienic quality of Indian spirits is unnecessary. No commensurate advantage would be derived from so doing as compared with the grave disadvantages and difficulties which are involved by the adoption of any such policy.

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* Such short period of maturation would have been of little use in the case of imported spirits. But, in the case of Indian spirits, where storage is so much shorter than at home, the case is somewhat different.

Correction Slip—page 193.

In line 27—

Substitute the word "mixed" *for* the words "highly contaminated."

Delete the asterisk after the word "yeasts" and *insert* it after the word "moulds."

In line 46—

Substitute the word "mixed" *for* the words "badly contaminated."

Delete the asterisk after the word "yeasts."

In line 47—

Insert an asterisk after the word "moulds."

In the footnote, line 1—

Substitute the word "moulds" *for* the word "yeasts."

CHAPTER XIV.

POISONING OF BAKHAR, PACHWAI, ETC.; AND NATURE OF CERTAIN YEASTS USED BY NATIVES.

The following chapter embodies the results of certain investigations made at the instance of the Excise Committee. In addition, a note is added on Kukra, a plant used for fortifying liquor in Assam, samples of which I also examined at the Committee's request.

References.—

(1) Letter from Deputy Commissioner, Lakhimpur (No. 3105, dated 20th January 1906).

(2) Secretary, Excise Committee (Dis. No. 143, dated 29th January 1906).

(3) Secretary, Excise Committee (Dis. No. 157, dated 1st February 1906).

(3) Deputy Commissioner, Bhamo (No. 304—IX-S., dated 16th February 1906).

(5) Superintendent of Excise, Rangoon and Hanthawaddy (No. 604-E.—4, dated 3rd February 1906).

(6) Superintendent of Excise, Bassein (No. 601—6-L—1, dated 3rd February 1906).

(7) Secretary, Excise Committee (Dis. No. 178, dated 17th February 1906.)

Yeast examinations.

Results of yeast examinations.—(1) In connection with the first reference a sample of yeast was sent which was said to have been "used to increase the intoxication in making laopani." The sample, however, showed an entire absence of poisonous ingredients. The yeast proved to be of a low feeble type, and was also highly contaminated with wild yeasts,[*] moulds and other micro-organisms.

(2) With regard to the sample of bakhar found in a pachwai shop at Raniganj, the results obtained were similar to those detailed at (1).

(3) Another sample of bakhar was sent by the Collector of Birbhum in connection with some fatal cases of poisoning in connection with bakhar. It was explained by the Secretary, Excise Committee, that the sample sent was not part of the supply which caused the death referred to by the Collector.

On analysis no trace of poison was to be detected.

(4) At the request of the Excise Committee the Deputy Commissioner, Bhamo, sent a sample of rice beer used by Kachins and of the yeast used in making it.

Rice beer and its yeasts.

Analysis of rice beer and yeast used in making it.—The result of analysis of the liquor was as follows :—

Alcoholic strength (True) ...	71·1 U.P.
Acidity	345·4 Parts per 100,000 of absolute alcohol.
Aldehydes	Very small trace.
Furfural	*Nil.*
"Fusel oil"	154·5 Parts per 100,000 of absolute alcohol.
Ethers	186·6 ditto ditto.

Here again the yeast was weak and badly contaminated with wild yeasts,[*] moulds and other micro-organisms. An experimental fermentation (carried out with sterile hop-wort) was very slow and feeble.

(5) By direction of the Excise Committee the Excise Superintendent, Rangoon and Hanthawaddy, sent for analysis samples of hlawzaye (rice beer) and of seye (jaggri beer), and also samples of the yeast used which is imported from China.

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[*] These yeasts were not examined for any saccharifying action, but it is probable that some of them were of this type. Here again time did not permit of further enquiry.

Burmese and Chinese Yeast.

The yeast was a species of saccharomyces cerevisiœ, and its characters were similar to those described at (4).

The result of analyses of the liquors was as follows :—

Analysis of Rice and jaggri beers.

Hlawzaye.

Alcoholic strength ...	... 87·6 U.P.
Acidity ...	... 230·8 Parts per 100,000 of absolute alcohol.
Aldehydes ...	... Very small trace.
Furfural ...	... *Nil.*
" Fusel oil " ...	... 230·3 Parts per 100,000 of absolute alcohol.
Ethers ...	... 92·3 ditto ditto.

Seye.

Alcoholic strength ...	... 88·2 U.P.
Acidity ...	... 190·1 Parts per 100,000 of absolute alcohol.
Aldehydes ...	... *Nil.*
Furfural ...	... *Nil*
" Fusel oil " ...	... 291·5 Parts per 100,000 of absolute alcohol.
Ethers ...	... 185·9 ditto ditto.

(6) By direction of the Excise Committee the Excise Superintendent, Bassein, sent samples of rice beer and of the Chinese yeast used in its manufacture.

The yeast was of the character and qualities described at (4) and (5).

The rice beer gave the following results :—

Alcoholic strength (True)	... 72·7 U. P.
Acidity ...	... 250·0 Parts per 100,000 of absolute alcohol.
Aldehydes ...	... Very small trace.
Furfural ...	... *Nil.*
" Fusel oil " ...	... 197·4 Parts per 100,000 of absolute alcohol.
Ethers ...	... 197· ditto.

I have already expressed my opinion in my verbal evidence before the Excise Committee that the addition of such poisonous substances as dhatura, nux vomica, aconite, etc., to pachwai or bakhar is certainly unnecessary, and should be absolutely prohibited and penalised. I quite agree with the Committee's recommendation that the possession of such poisonous substances in licensed premises should be a punishable offence. I have offered some suggestions in my evidence before them as to the substitution of pure yeast for bakhar, but of course the subject would require much further and more careful consideration if any action on such lines is contemplated.

Note on "Kukra," a plant alleged to be used to fortify liquor.

" Note on Kukra."

Alleged symptoms, etc., produced by Kukra.—At the request of the Excise Committee, the Commissioner of Excise, Eastern Bengal and Assam, forwarded to me a specimen of "Kukra" which was stated by the Civil Surgeon of Cachar to be used by distillers for strengthening the *mahua-wash.* The spirit prepared from this wash was stated to cause "great and lasting intoxication" .... "rapid intoxication and bad headache and diarrhœa". "It is not now used, for fear of detection, as inspections are frequent by police and others". "The plant grows everywhere".

The plant is also used for stupefying fish ; and in the form of a decoction is "poured over the plinth of a house" so as to "dislodge worms and insects." It is also said to "excoriate or irritate when applied to the skin" or eyes.

Experiments here.

19 c. cs. of an acid, alcoholic extract of the *Kukra* plant (made thus so as to imitate the natural conditions) were administered *hypodermically* to a dog of 16·8

kilos weight with negative results. 15 c. cs. of a watery extract also was given subcutaneously to another dog of 17·9 kilos with no result. The Reporter on Economic Products, Calcutta, informs me that this specimen of "Kukra" is *Polygonum flaccidum* (Meisu) and that it is very widely distributed in India; that some of the species have medicinal actions and that *P. amphibium* is said to have been used as a substitute for sarsaparilla. Dragendorff pronounced *P. rivulæ* to be a narcotic fish-poison; and Perkin obtained emodin from the root of *P. Cuspidatum.*

It appears that the Chemical Examiner to Government, Bengal, examined a specimen of Kukra (*P. glabrum*), sent also from Cachar, a number of years ago.

Result of a previous examination of Kukra.

"Several specimens of a plant called 'Bish-Kurki' were sent from Cachar for examination. It was stated that the plant was frequently added to country spirit, which it was believed might have thus communicated to it some specially noxious property. The plant was identified by Dr. G. King as *Polygonum glabrum* and on chemical examination and physiological application was not found to possess toxic properties."

(Pharmacographia Indica, Part VI, page 152).

My chemical analysis of the Kukra samples sent here gave negative results as regards the separation of any active poisonous substance. *Presuming that the active principle has not been destroyed or modified in transit*, it would thus appear from this *preliminary investigation* that this species of polygonum has no marked active properties.

Tentative conclusions.

Should the matter be considered of sufficient importance, a more extended investigation can be made later, if desired. This would be a somewhat lengthy matter and has, of course, been one which time has not permitted me to pursue further at this stage. If, however, the statement that the plant is no longer used for drugging liquor is correct then the subject loses much of its practical interest to the Excise Administration, and further investigation, from this point of view, is unnecessary.

E.

DISTILLERY SECTION.

Chapter XV.—Methods.
Chapter XVI.—The Dacca Distillery Case.
Chapter XVII.—Industrial spirits, etc.

CHAPTER XV.

METHODS OF SPIRIT MANUFACTURE EMPLOYED IN INDIA, WITH SUGGESTED IMPROVEMENTS.

Defects in Indian made spirits due to ignorant methods of manufacture and supervision.

In an Appendix at the end of this Report will be found details of manufacture in all Indian distilleries. It would be of little use to comment separately on these as, generally speaking, the defects found are common to most and chiefly arise from ignorance of the technicalities necessary for the production of spirit of sound quality on economically advantageous lines.*

Acids and Furfural too high in amount in general.

High acidities chiefly due to bad fermentation and over-prolonged distillation.

High amounts of furfural due to highly acid wash acting on vegetable matter of wash and to defective methods of conducting distillation.

The products of every distillery throughout India have now been analysed and the results have been seen clearly to point to the *prevalance of two chief faults as regards quality—excessive acidity and too high proportions of furfural.* In addition, the methods of manufacture are exceedingly wasteful not only as regards the yield from the fermentative bases employed but also as regards loss of spirit during manufacture and that from easily preventable causes. As regards the excessive acidity present in so many cases, the chief causes are crude, bad and wasteful methods of conducting fermentation and improper methods of distillation. The furfural, on the other hand, is chiefly formed during distillation by the action of the highly acid wash on the solid vegetable matter in the wash, assisted by over-heating of the still. Distillation is unduly prolonged as a rule and thus furfural and volatile acids (both of which are relatively high boiling-point constituents) are driven over in comparatively large amounts. Low boiling point ingredients tend to chiefly come over early during the distillation, *e.g.*, strong (ethylic) alcohol, ethers, aldehydes and certain constituents, of fusel oil (*e.g.*, the propyl alcohols). The relatively high boiling point constituents, *e.g.*, volatile acids; furfural; butyl and especially amyl alcohols (the chief constituents of "fusel oil"); and certain high boiling point ethers (also included under the head of "fusel oil") come over mainly during the later stages of distillation.

The following statement will show this perhaps more clearly.

The so-called "impurities" of spirits can be grouped as follows:—

	PRODUCED CHIEFLY DURING	CHIEFLY DISTILLING OVER.
1. *Acids*—		
(*a*) Volatile	Fermentation	Late.
(*b*) Fixed	Casking	Not at all.
2. Ethers (compound ethers or esters).	Fermentation and distillation ...	Early.
3. Furfural	Distillation	Late.
4. Aldehydes	Fermentation and especially distillation.	Early.
5. "Fusel oil" (a mixture of higher alcohols and high boiling point "Ethers, etc.")	Fermentation	Late.
6. Volatile alkaloidal bases ...	Not known (fermentation) ...	Late.

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* No attempt has been made to *exhaustively* discuss the defects of, and remedies for, present conditions of manufacture. A comparatively brief survey is all that is here attempted of this part of the subject.

Acidity.—This may be "fixed" or "volatile" according as the acids cannot or can distil over. The fixed acids in spirits are derived from the cask by absorption from the wood of tannic and other acids. In the case of our present series of analyses these fixed acids have usually not been estimated as the spirits had been freshly distilled and sent here in jar or bottle in by far the greater proportion of samples, so that "fixed acidity" was absent in such cases.

Volatile acidity chiefly of importance in spirits.

The volatile acidity is what concerns us chiefly. It mainly consists of acetic acid (the active principle of vinegar) as this acid is the direct product of oxidation of ordinary (ethylic) alcohol.

Formation of acid during fermentation.

It may be again explained that ethylic alcohol on oxidation and by the action of the acetic ferment becomes changed first to aldehyde (acetic aldehyde) and finally to acid (acetic acid). The preponderance of acetic aldehyde and of acetic acid in the groups of aldehydes and of volatile acids found in spirits is thus explained by the fact that ethylic alcohol, their common source, is the chief organic body present. The other volatile acids present are thus usually insignificant in amount as compared with acetic acid. The volatile acid in spirits is chiefly produced during fermentation but to some extent also during the subsequent distillation. To illustrate this, I append a table which shows the large amounts of acidity formed in Indian washes by bad methods of fermentation.

—	Milligrams per 100 c. c. absolute alcohol (parts per 100,000 approximately.)	Percentage relation of acidity to alcohol.
Dadar toddy wash	7534·9	7·5
Do. do.	6989·0	7·0
Do. do.	1276·0	1·3
Bankura mahua wash	587·8	0·6
Burdwan cane gur wash	1666·6	1·7
Patna gur wash	3000·0	3·0

Prevention of excessive acid formation.

This statement shows that the washes in some of these distilleries may be 15 times more acid than in others shown in the table. The prevention of excessive acid-formation during fermentation in most Indian distilleries means a reform as regards almost every detail of the process. Such an improvement can only be hoped for by providing an adequately trained manufacturing, and Excise superintending, *personnel.* This should not present many difficulties.

Removal of excessive acidity.

Fermentation.—In the majority of Indian distilleries every detail of the process needs improvement, *e.g.*, as regards cleanliness of stores, fermenting vessels and sheds; the use of proper fermenting vats; a sufficient water-supply; proper mashing in every particular; proper stirring of the wash during fermentation; regulation of temperature of fermentation and of acidity; a proper method of pitching with sound yeast; the avoidance of an unduly prolonged fermentation; straining off the solid matter of the wash before feeding the still; no delay in distilling the wash on completion of fermentation; still-feeding by gravitation: and generally proper technical control of the whole process.

Cleanliness of store.

A few of the more important points may now be very briefly mentioned.

The necessity for cleanliness of the stores for holding the fermentative basis used is obvious enough to any one who has visited an ordinary Indian distillery and seen the filthy arrangements for storage and the swarms of flies and other insects which batten on the sugary material in the godowns. Wire-gauze doors and windows and *pucca* floors should be used.

And of fermentation-plant, and premises.

Of even greater importance is the matter of cleanliness of fermentation-sheds and vessels. Dirt means contamination of the set-up washes by very undesirable forms of yeast and other germs which by their action lessen the alcoholic yield and produce not only souring of the wash but also certain varieties of by-products which later re-appear in the distilled spirits.

The floors of the sheds in most Indian distilleries become from time to time soaked with frothing-over wort and droppings from the fermented wash on its way to the stills. This forms an excellent medium for the growth of wild yeasts and acid-forming germs, etc., which in due course find their way into the wash.

Absolute futility of attempting to improve fermentation unless suitable yeast is rendered available for use.

If a sound vigorous yeast is employed with certain precautions for "pitching" the wort it is found that the growth of wild yeasts and other micro-organisms is prevented in great measure. But in most Indian distilleries no yeast at all is used and the fermentation is effected by means of any stray yeast cells floating in the air which of course means that in nearly every case very disadvantageous fermentation results (as most of these yeasts are not of the proper variety). Also the yeast becomes still further weakened by the action of other germs which find their way into the wash and set up acid and other fermentation. The whole process is haphazard and in general about as wasteful and bad as can be imagined. Any reform of fermentation demands, therefore, the use of sound yeast and instruction as to how to properly conduct the pitching process and also how to treat the yeast obtained from the wash for use in subsequent fermentations.* It is essential to provide some central yeast-growing agency where good sound yeast, specially suitable for the particular basis used, *e.g.*, mahua, sugar, etc., may be obtained at all times. From time to time (especially under Indian conditions) the yeast in use will tend to become so badly contaminated that fresh yeast will have to be obtained. So that here again a central agency becomes necessary.

Central yeast-growing agency a necessity.

Without some assistance from Government at the start (and for several years to come until the spirit industry is self-supporting in this respect) little, if any, improvement in manufacture need be expected. The agency must be a responsible one. It would never do to trust to existing European breweries or distilleries for supplies of yeast for these reasons :—

(1) Most establishments of the kind do not maintain their yeast-growths throughout the year.

Yeast-supply agency should be Governmental, at the start in any case.

(2) The yeast in use in many such establishments has been found to be of feeble and poor quality and in many cases the methods adopted as regards yeast are little in advance of the worst native procedure.

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*Thus Mr. Weinberg in his Report on Assam out-still spirits (1904) says : "A thorough investigation of the yeast would be very desirable *and is imperative if any rational improvements in the fermentation are desired*" (page 14) ; and he also later recommends the establishment of a "central yeast factory" for the supply of sound yeast to distillers.

The Central Provinces Excise Committee (1904) also note that no artificial ferment is employed in the distilleries there and that hence alcoholic fermentation is prolonged and acetic fermentation usual.

Similar recommendations are made in nearly all other recent reports on the subject.

(3) There would be no control of quality of yeast possible. The particular firm would supply yeast of such quality, etc., as it found most convenient and there would be no check on this whatever.

(4) At any time the firm might find it convenient to discontinue its supply and the making of fresh arrangements would be likely to lead to a good deal of delay, thus causing much inconvenience to distillers who would rely on being constantly supplied by such an agency.

(5) The cost of yeast supplied by a private firm would be much greater than a Government (even temporary) agency could afford to charge.

Government would conduct such an enterprise in the interests of the industry and with special reference to the production of wholesome liquor. The private firm would naturally conduct such a side-business in its own interests and would not be likely to undertake it unless it were certain to prove a very profitable undertaking. The yeast being produced with the view of promoting the production of wholesome liquor should be sold at the cost price of production *plus* carriage (usually by post) to destination.

The agency might cease to be Governmental later, if constancy of supply and quality be guaranteed by contractor.

The supply need only be continued until the distillery trade in this country was found to be self-supporting in this respect. The measure would be undertaken in the interests of the industry which would thus constantly be supplied with pure, suitable and cheap yeast so that any complaint of interference with trade by Government supply of a trade-article would surely be unreasonable. At the same time, such an agency would render it possible for *pachwai*-makers and licensed bakeries to obtain sound yeast. At present *pachwai* is largely made by the aid of a feeble native "yeast" (*bakhar*) which is not infrequently drugged with poisonous alkaloids, such as aconite, nux vomica, dhatura, etc., fatal results having occurred in several instances. And again the use of filthy curd in most native-managed bakeries produces sour, indigestible bread. There is at present in most cases no other alternative, but licensed bakeries might be encouraged or even required to use sound yeast in the future were it available from some such agency as suggested.

Use of proper fermenting vessels essential.

Proper fermenting vessels.—The earthen pots in use at present in most native distilleries should be replaced by proper barrel or vats (as already in use in several Indian distilleries) which should be fitted with stirrers driven by hand-power or otherwise, instead of hand-stirring as at present. This is a most necessary reform as the present filthy arrangements in this respect make any improvement in fermentation practically out of the question. The provision of such vats would initially be somewhat more costly but the saving resulting from the greater alcoholic outturn and in other ways would speedily justify the change.

A sufficient water-supply.

A sufficient water-supply.—Without enough water, adequate condensation of the alcoholic fumes during distillation becomes impossible. As regards cleanliness of premises, etc., the necessity is further apparent. The dilution of the spirit to the proper degree for issue also demands the use of a sufficiency of good water. At present the same (hot) water is used repeatedly without any attempt at cooling for "condensation." The condensing tub frequently is allowed to overflow for hours at a time thus occasioning great loss of water.

Proper "mashing" in every particular essential.

Proper mashing in every particular.—The details of this are too numerous to discuss fully here. They can only be taught by practical means in a distillery school. Among other points, however, mention may be made of the determination of the proper proportions of ingredients for the different fermentative bases employed in India; a suitable degree of dilution; proper pitching with sound yeast; the observation of the progress of attenuation so as to know when fermentation has been properly completed; proper stirring of the wash during fermentation to promote better action of the yeast; some regulation of the temperature of fermentation; straining off the solid matter before passing the wash into the still which latter should be preferably fed by gravitation or pump (and not by hand-carriage as at present). The liquor should also be piped from receiver to storage tanks. The whole process most urgently requires intelligent and trained supervision.*

Necessity for adequate training and certification for, and skilled supervision of, manufacture.

Such reforms can only be obtained by training the supervising and inspecting staff and insisting on the employment by distillery-owners of competent distillers, ("certificated" after a course of instruction at a Distillery School) as one of the conditions for obtaining a distillery-license.

Distillation.—The following figures are arranged to show the degree in which high proportions of acid and furfural occur with different modifications of the distillation process, as well as with different fermentative basis :—†

Effect of method of distillation and of basis used on acid and furfural production.

Fermentative basis used ; type of still and methods of heating it.	No. of samples analysed.	No. of samples showing high acidity amounts.	No. of samples showing high furfural amounts.
Rice, Raisins, Dates and Toddy spirits.			
Fire heated potstills, single distillation	29	24	13
Ditto, double distillation	20	16	12
Steam heated stills, single distillation	4	4	4
Ditto. double distillation	4	2	3
Gur (cane, date, &c.), Jaggery, molasses and shira.			
Fire heated potstills, single distillation	66	58	9
Ditto, double distillation	3	2	*Nil.*
Steam heated still, single distillation	3	3	*Nil.*
Ditto, double distillation	1	...	...
Mahua spirits.			
Fire heated potstills, single distillation	156	141	88
Ditto, double distillation	17	13	14
Steam heated stills, single distillation	4	3	4
Ditto, double distillation	3	3	3
Miscellaneous spirits (spiced and flavoured).			
Fire heated potstills, single distillation	38	20	16
Steam heated stills, single distillation	8	4	2
Sugary bases in patent continuous stills	18	...	...

From a consideration of these results, first in the case of potstills, it will be seen that between single or double distillation, fire or steam heat, there is little if anything to choose. If anything, the figures tend to show that double distillation produces a higher proportion of furfural, but the numbers for double distillations are hardly sufficient to justify very definite conclusions on this point.

As regards the relation between the fermentative basis used and furfural production :

—	No. of spirits analysed.	No. yielding excessive furfural amounts.	Percentage.
I—Rice, raisins, date and toddy spirits	57	32	56
II—*Gur*, molasses, &c.	73	9	12
III—*Mahua*	180	109	60
IV—Miscellaneous (spiced, flavoured) from mahua and other bases	46	18	39

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* "The above considerations all tend to one conclusions, namely, that the more capable the distiller and the more efficient his plant the better are his results from the point of view of quality as well as quantity."

Report of Central Provinces Excise Commission (1904), page 56.

† A very large amount of other chemico-technological work has been done here in order to arrive at definite opinions on various points, but is of much too technical a nature to be now detailed. The results obtained will prove extremely useful later in working out practical distillery-reforms.

The relation indicated is what one would expect, namely, that those washes which contain a quantity of solid vegetable matter (as I, III and IV) would yield the highest amounts of furfural while *gur* and molasses spirits give markedly less proportions.

With regard to patent still spirits, in only one case was an excessive amount present, and we may ascribe this general result chiefly to the retaining power for high-boiling products of the still and to some extent to the fact that the basis used was molasses, or other sugar-refuse.

Having regard to the above facts, it would serve no useful purpose to describe here in detail the various types of stills inspected by me. It will suffice to very briefly mention their chief defects and the remedies for these.

Heating of potstills.

Methods of heating potstills.—As regards the potstill itself, it has been seen that the method of heating appears not to be of so much importance, always provided, however, that the wash is strained and that the heating is fairly regular and not too violent or prolonged. It is true that steam heating is more regular, rapid, and controllable than fire heating, but the practical advantage as regards output is not sufficiently pronounced to justify any marked preference for steam heating.

Feeding stills by gravitation.

Feeding of stills by gravitation.—The method of feeding the stills should be by gravitation (or less preferably by pump). The feeding by hand at present so much in vogue is not only very inconvenient in every way, but leads to loss by evaporation of alcohol and spillage; and contaminates the floor, etc., of the distillery with the spilt wash. This last forms a good medium for the growth of germs which in due course help to further contaminate the washes subsequently set up.

Efficient still heads.

Necessity for efficient still-head.—A good still-head is much needed in order that a proper degree of rectification may be ensured. Scarcely any of the patterns in use are really efficient. I may mention here that I have succeeded in devising a new and simple pattern of still-head which could easily be fitted to most existing stills. The use of this head on a small scale has been productive of good results. Before finally recommending its adoption I wish further to experiment with it on a manufacturing scale in order to test its suitability for all classes of wash, etc.

Defects of condensation methods.

The condensation arrangements in general are about as faulty as could well be imagined. Economy in water appears often to be the chief consideration and neglect or ignorance of the necessity for changing the condensing water is very general.

Graduation of worm's diameter, etc.

There is in nearly every case no attempt made to graduate the diameter of the worm so that it may progressively diminish in calibre, or to regulate the length of the worm according to the capacity of the still. The condensing worm is occasionally made of copper but in such cases no attempt is ordinarily made to protect the liquor from serious contamination by the copper salts produced by the action of the acid spirit on the metal. This whole question requires careful expert consideration.

In Bombay a rough Excise test is used for the detection of copper salts but is of little practical value. Thus, a number of spirit samples sent from distilleries in various Provinces were tested for the presence of copper salts. In 60 per cent. of the samples examined they were absent ; in 24 per cent. they were present in marked amount ; and in 16 per cent. (including some samples from the Bombay Presidency where copper salts are tested for at distilleries) such marked amounts were found as to render the liquor unfit for consumption.

The elementary principle of a counter-flow (*i.e.*, the cold water flowing in at the foot of the condensing tub and out at the top so that the alcoholic vapours may leave the worm-end at the same temperature as the water entering the tub) is usually altogether neglected. In fact, in many instances the condensation arrangements are worse than if air cooling of the worm alone had been resorted to for the worm is surrounded with unchanged water which is often almost as hot as the vapour it is meant to cause to condense.*

Extreme wastefulness of present archaic methods.

We seem to step back into Vedic times in many distilleries where the simple device of hollow bamboos wrapped round with string (supposed to be kept wet) is used. From these archaic "condensers" the alcoholic vapour issues uncondensed and escapes in great part into the air and this is a cause of considerable loss of alcohol to the manufacturer.

Aldehyde production.

Then again these hot alcoholic vapours supply the best conditions for aldehyde-production and, were it not for the open receiver and the free vent to the air (both otherwise most undesirable and wasteful) which allow the highly volatile aldehyde to pass off, the liquor would certainly contain large proportions of aldehyde. Here again is a cause of loss of spirit, for alcohol that is oxidised to aldehyde or acid is clearly so at the expense of the alcohol; and not only this but the acid formed tends to spoil the liquor's quality.

In the following table the first two cases serve to show a growth in the proportion of aldehyde (stated in parts per 100,000 of alcohol) during distillation:—

Amount found in wash.	Amount after first distillation.	Amount after re-distillation.
(1) 11·1	17·1	25·5
(3) Unreadable trace	2·5	7·8
(3) 40·0	30·0	...

In one case the wash was practically free from aldehydes, while in the other it contained an appreciable amount. The third case (from a crude native *mahua* distillery) shows a fairly large amount in the wash which on distillation becomes 25 per cent. less, evidently from loss at the worm-end or from the open receiver.

Insecurity of present methods from the Excise point of view.

Other obvious defects are the absence of proper safes between the worm-end and receiver thus allowing easily of illicit abstraction of spirit; the open receiver which allows free loss of alcohol by evaporation and surreptitious abstraction; the general absence of some simple arrangement such as a "jacket" containing running water for cooling the receiver which would tend somewhat to lessen loss by evaporation, etc.

Only remedy for present state of affairs is adequate instruction and skilled supervision throughout.

It seems unnecessary to continue to enumerate the list of defects. The only real remedy is instruction combined with expert supervision, if any improvement is to be effected.

PATENT-STILLS *VERSUS* POT-STILLS.

Patent-stills *versus* Pot-stills.

In the Finance Department of the Government of India's Resolution No. 1975-Exc., dated 6th April 1005, a scheme for the greater centralisation of distilleries was mentioned with approval. This is desirable in the interests of better control and improvement of manufacture generally. But this apparently can only be obtained with certain modifications of present conditions such as the provision of numerous bonded warehouses each with a reliable Excise-man in charge.

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* The Central Provinces Excise Committee's Report (1904) also directs attention to the most insufficient condensation; water changed only on a fresh distillation; the liquor leaving the condenser while quite hot and much of it escaping uncondensed. They also draw attention to the faulty receivers with a space between the worm-end and receivers.

Pot-stills, if properly worked, will meet all requirements.

The resultant question of casking-obscuration has been already dealt with in Chapter VIII (on obscuration). It has been previously pointed out that the chief defects of quality in Indian spirits occur through ignorance of the proper means of control of manufacture. Pot-stills, which are the most natural and the simplest mode of production, are not inherently more defective as producers of wholesome spirit than patent stills. That is to say, pot-stills *when properly worked* may be relied on to turn out quite as wholesome a liquor as patent-stills. There is thus no reason for any drastic reform *quâ* pot-stills *from the point of quality.* It has already been pointed out that spirits of even as low alcoholic strength as 60 U.P. can be made in pot-stills and will keep and carry as well as patent-still spirit of very high strength.

Pot-still can turn out very high strength liquor with proper management.

The advantage of the high strength patent-still spirit is obviously that an equal bulk of stronger spirit can be more profitably transported to a distance than one of weaker strength but pot-stills can be brought by proper working to turn out quite sufficiently strong spirit. The difficulty now and in the past as regards pot-still spirit in India appears to be that badly made, excessively acid liquor of low alcoholic strength would not keep or carry and the obvious remedy for this is first *to improve manufacture* and to issue at a high strength to bonded warehouses. But as regards keeping power the question of alcoholic strength is of subordinate importance (within certain limits) to that of "clean" manufacture as has been already shown in the chemical section.

No appreciable difference in hygienic quality between pot-and patent-still spirits.

The difference in wholesomeness between pot-and patent-still spirit appears to be insignificant, or rather inappreciable, as the by-products present in spirits are found to be present in such relatively small quantities that their action is of no practical hygienic importance. They are the *natural flavouring agents of spirits* and hence in reasonable amounts are not to be regarded as impurities.

Flavouring essences used in patent-still spirits.

If one removes most of these flavouring agents by the patent-still then others have to be added in their stead and though it may be claimed that one is adding fixed proportions of known ingredients the result obtained is somewhat different in the two cases, and by no means pronouncedly in favour of the artificial agents.

It has been found necessary to supervise carefully the quality of these flavouring agents (*e.g.*, as in Madras) as they are sufficiently costly to make profitable the substitution of cheaper and often very deleterious products for those used in good class essences. This is another point that will have to be taken into account in according sanction to the use of such essences in Provinces where they have not hitherto been in use. Systematic supervision by an Expert Excise chemical agency is here again a necessity.

Relative cost and yield of patent and pot-still plant.

The patent-still plant is very complicated and initially expensive as compared with pot-stills. For instance, a Russa pattern pot-still (which could cheaply and readily be made efficient by the addition of a good still-head) costs Rs. 800 (£53·6-8) for a still of 500 gallons capacity; and Rs. 590 (£39·6-8) for one of 340 gallons capacity as against a $3\frac{1}{2}''$ pipe patent-still costing £3,000 and a 2″ pipe patent-still costing £1,800 (exclusive of carriage to India).

The yield of the patent-still is relatively greater ($3\frac{1}{2}''$ pipe = 550 gallons; and 2″ pipe = 200 gallons per hour of 67° O.P. strength, with the best type of plant). But, on the other hand, this requires a considerable expenditure of fuel and the cost of plant and management has to be set off against it.

In India, the relative cost of pot and patent-stills is further modified by considerations of relatively greater cheapness of fuel, fermentative bases, labour and pot-still plant. The cost of European management in the case of patent-stills has also to be considered.

The high-strength of liquor produced by the patent-still is perhaps its greatest advantage, but this consideration requires modification when we find that several of the patent-stills in India produce liquor not much stronger but in certain cases even weaker (*e.g.*, Vizagapatam: average strength, 14·2° O.P.) than well-distilled pot-still spirit. That is to say, the pot-still, if improved in the manner I have previously indicated, will certainly produce a much stronger and purer liquor than at present. 30 to 50 over-proof is the average strength of spirit taken from the receivers in order to be bonded at the Simla, and 40° O.P. at the Sujanpur, pot-still distilleries. This is quite as strong a spirit as need be produced and is even stronger than the produce of certain Indian patent-stills. (In the Scotch and Irish whiskey-distilleries the spirit on an average is obtained at 17—14° O.P. and 45° O.P. and bonded at 11° O.P. and 25° O.P., respectively). In Indian distilleries, the pot-still foreshots and tailings could be re-distilled to a high strength and used for industrial purposes.

As regards the relative cost of working pot and patent-stills it must be remembered that the advantage the latter are believed to have is obtained not by the method of distillation alone for where patent-stills are used European skilled management is the rule and fermentation is generally under more or less careful control : hence a much larger spirit-yield results. So that when the pot-still spirit industry is placed on a sound basis as regards—

(1) the alcoholic yield from fermentative bases by improved fermentation methods; and

(2) when the pot-still is rendered more efficient by means of a good still-head and proper working it is likely that the advantage of cheap labour and fuel and the low initial cost of plant will render it able to compete successfully against patent-still conditions.

There would thus appear to be no case for sweeping away the pot-still industry on the score of the better quality (or "keeping power") of liquor produced by patent-stills, and the Bengal Excise Commission (Report, page 111) state that "the main argument in favour of substituting European for native processes is the greater wholesomeness ascribed to the liquor manufactured by the former."

Pot-stills need not be replaced by patent-stills.

No grounds on the score of quality for substituting patent for pot-stills.—The risks of an increase of illicit distillation from substitution of machine-made spirit for even the accustomed pot-still liquor cannot be ignored. "The strong feeling that spirit made by European processes does not agree with people of this country must also be considered" (*op. cit.*, page 111). It is no doubt the case that substitution could be effected in time, but there is no reason for doing so on the score of improved quality. For as has been pointed out previously the two chief defects of Indian-made liquor are easily removable by means of improved manufacture. So that it is needless to run the risks incidental to so sweeping a change as the destruction of the indigenous pot-still industry in favour of a patent-still system.

To sum up—we have, it seems, two alternative plans—

Pot-still system can be sufficiently centralised and improved as to outturn and quality.

(1) To improve existing processes of manufacture, which can readily enough be effected by the agency described, and, for increasing administrative control, to centralise distilleries much more than at present. This alternative would have the advantage of preserving a large native industry.* It has been shown that the pot-still if properly employed (as it would be under intelligent management) is *quâ* the quality of its produce, not inferior to the patent-still.

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* The returns obtained by me in 1904 from the various Provinces show that over 100 Indian distilleries use pot-stills and only 8 patent-stills. So that the Indian industry is essentially pot-still.

Patent-stills unnecessary and in many ways undesirable.

(2) To sweep away wholly or partially the existing native distilleries and to substitute large capitalist concerns working expensive patent-stills, which the owner of such concerns in India hitherto have found to require European management. On the score of quality this appears quite an unnecessarily drastic measure and has many grave inherent disadvantages already well known to Government.

In any scheme for greater centralisation of distilleries, bonded warehouses for district supply would appear to be necessary.—In either case, the greater centralisation of manufacture involves bonded warehouses, for the retailer can never be trusted to break-down for retail vend what he would receive direct from the distillery, as experience shows that this gives opportunities for serious irregularities. Thus the extra cost necessary to provide a reliable supervising establishment at distilleries and bonded warehouses is a necessary drawback to any such centralisation system but with more trustworthy supervision the present admitted leakage of revenue will tend to disappear and the net result to Government will come in time to be a considerable gain. By trustworthy supervision is meant:

Trustworthy and *skilled* Excise control and supervision the first essential for reform coupled with adequate training of the distiller.

(1) an Excise-man (well enough paid to minimise temptation) at each large central distillery to control issues and well enough trained to know, and to report, when undesirable irregularities in manufacture are occurring*.

(2) Next a trustworthy Excise official in charge of each bonded warehouse to assess duty on issue (including obscuration arising from casking); to dilute liquor to fixed issue strengths (if this policy is decided on); to supervise the flavouring of patent-still liquor after assessment of duty and dilution to its issue strength; and (if decided on) to "dye" for identification the diluted liquor before issue.*

(3) Even more important than either of these classes of officials would be the *expert* Excise Inspector who would constantly be touring round distilleries and bonded warehouses checking and comparing distillery issues as against the corresponding warehouse issues; observing the processes of manufacture, etc., and in general keeping the Commissioner of Excise in close touch with his administrative charge.

It is certainly only by "hard driving" that efficiency and honesty can be ensured in any Excise executive agency. In the past, these essentials are generally acknowledged not to have been obtained in India and until we have real *expert inspection and control* in Excise matters little improvement can be hoped for. In this respect, Madras has for several years successfully shown the way to other parts of India.†

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* This, of course, is not by any means meant to indicate the full extent of their duties.

† The subject of the manufacture of out-still liquor or of fermented liquors does not come within the scope of my enquiry.

CHAPTER XVI.

THE DACCA DISTILLERY CASE.

The following case will serve to illustrate the state of affairs which at present exists as regards Excise control of outturn of spirit. The Dacca distillery is even in many respects in a better condition than most other native distilleries. So that it will be seen how urgent is the necessity for the introduction of proper Excise control and of rational and business-like methods of manufacture.

Nature of reference.

Nature of Reference.—On 26th January 1906, the Excise Commissioner, Eastern Bengal and Assam, wrote (under instructions from the Excise Committee) to me advising despatch of samples of the materials in use at Dacca distillery and giving some details as to manufacture. He also asked me to conduct experimental fermentations and to report, as the outturn of spirit at Dacca appeared to be too high as compared with that of other distilleries.

On 29th January, the Excise Committee forwarded some supplementary correspondence on the case and pointed out that the time taken in fermentation is excessive and that an explanation is required. My opinion was also asked on the subject of the investigation conducted in 1886 into the general question of fermentation in Bengal of which a record was furnished.

The spirit at Dacca has an offensive smell and the reason of this was also asked.

Yield of Spirit at Dacca distillery.—First as regards theoretical yields, *i.e.*, maximum possible of alcohol obtainable from the *gurs* used :—

Yield of spirit at Dacca Distillery.

(*a*) *Date gur.*—This was found by analysis to contain invert sugar, 22·53 per cent., and cane sugar (as invert), 47·61 per cent.; or total available glucose 70·19 per cent., so that one maund of date *gur* = ·7019 maund of glucose. Now 100 parts of glucose yield 51·11 per cent. of alcohol by weight, so one maund of this *gur* should give 6·54 gallons of L. P. spirit as a maximum.

As regards available sugar in added spent wash.—Eighteen gallons were used per maund of *gur*. Analysis shows that the unfermented sugar left in the wash would give ·03 gallons of L. P. spirit so that 6·54 + ·03 = 6·57 L. P. gallons which is the total possible yield. The Excise Commissioner reports that 5·8 L. P. gallons is the average yield, which is 88 per cent. of the theoretical yield, *i.e.*, all but 12 per cent. of the possible alcohol is obtained. Now, in European distilleries 85 per cent. of the total possible yield is considered good, so that this Dacca result may be called excellent. If, however, the sample of date *gur* examined by me was below the average in sugar-content or had fermented on its journey here (as appeared probable from its condition) the theoretically possible amount would have been larger; and the percentage yield smaller. For example, if the *gur*, at the time of fermentation, had contained 75 per cent. of glucose (instead of 70·19), the theoretical yield would have been 7·0 L. P. gallons of which the average amount, *viz.*, 5·8 gallons, is only *83* per cent.; or roughly speaking every 1 per cent of sugar in which the sample was deficient makes the average yield appear one unit better when expressed as a percentage of the maximum possible.

(*b*) *As regards the theoretical yield from the cane gur.*—This sample was found by analysis to contain invert sugar, 15·88 per cent.; cane (as invert sugar), 47·27 per cent.; total available glucose, 63·15 per cent. or one maund of cane *gur* = ·6315 maund of glucose. Therefore, as before, one maund could yield 5·89 L. P. gallons. Add 0·03 gallon for the wash and the total possible yield is 5·92 gallons.

The Excise Commissioner reports 5·5 L. P. gallons as the average yield, which represents 93 per cent. of the total possible. This is again assuming that the spent wash sent contains not less sugar than usual and that the sample of cane *gur* has neither deteriorated on the journey, nor was an inferior sample.

Speaking generally, there appears no reason to suspect any wrong practice merely on the ground that the yield is of this magnitude. The proper inference appears to be that other distilleries are wasting a very large proportion of their sugar basis. It is true that the yield appears slightly higher than could be expected on the data given, but, as stated, the samples of sugar probably gave low analytical results owing to their condition. Even higher yields are known to have occurred. For example, the *gur* used by Babu Obhoy Chandra Das in his experiments in 1886 yielded as much as 6·144 gallons of L. P. spirit per maund, according to Colonel Warden's calculation of the results. Assuming that this represented 85 per cent. of the total possible yield (and his conditions were not likely to give a higher percentage) then the *gur* used in his experiments contained 77·7 per cent. of available glucose, and this is quite a reasonable amount. Similarly the record yield of 6·93 L. P. gallons (*vide* Inspector's notes) indicates a still better quality of *gur*.

Necessity for ascertainment of true sugar-content of material and of average yield and range from various bases.

The importance of knowing the true sugar-content of the material used in such experimental work, also the *average* amount and the *variations*, for revenue purposes generally, is probably now manifest without further elucidation.

Of course, it must be taken for granted, that the recorded quantities of material used were correctly weighed. There is evidence that in some cases the material is estimated by *bulk* and not by weighment.

Time of Fermentation.—If a European distiller were required to carry out this fermentation he would naturally—

(1) Inoculate the wash with a well-grown yeast and not leave the process to chance fermentation.

(2) Arrange to ærate the wash efficiently.

The first point is neglected in nearly all Indian distilleries, so this is no explanation of the delayed fermentation at Dacca in comparison with other distilleries.

Time of fermentation.

The second point is probably the chief cause of prolongation, complicated by the fact that Dacca is one of the few distilleries where the wash used is almost sufficiently diluted. In distilleries where only 2·5 to 3 parts of liquid to one of solid are employed, the wash ferments more or less steadily for a time and then the fermentation dies away. Fermentation is then considered complete by the crude method of observing the cessation of bubbling; but as the low yield of alcohol proves, only a portion of the available sugar has been utilised.

Dilution of wash.

At Dacca, the dilution of the wash is such that nearly the whole of the sugar is enabled to ferment, and as the amount of such fermentation-work is, say, a third greater than in other distilleries so the time required is proportionally greater. Of course, chance fermentation may set in more slowly at Dacca than at some other distilleries and time be also lost in this way; but such an explanation would in the nature of things only be guess work.

The offensive odour of spirit noticed may be due to—

(1) The nature of the water used. This is stated in the Committee's Inspection Note to be of poor quality.

(2) Other micro-organisms (*e.g.*, putrefactive) acting on a wash kept too long under tropical conditions.

Offensive smell of spirit.

(3) Dirty surroundings generally.

It is extremely difficult to assign a cause without a personal visit to the distillery. But a similar evil is well-known in European breweries by the name of "brewers' stench" and is greatly dreaded. This is due to a wild yeast and can only be eradicated by costly and scrupulous cleansing of the brewery and all vessels.

General observations in reply to the Excise Committee's letter.—The special case of this distillery, in some respects superior to the generality, affords an excellent example of that need for technical knowledge of the subject which has been already referred to. The correspondence sent in connection with this Dacca case also shows how much time, labour and material may be wasted without obtaining adequate results.

Technological details.—I may now very briefly draw attention to the following points :—

1. *Non-use and Misuse of Saccharometer.*—At one time a saccharometer was employed in this distillery, but apparently it was broken some 2 or 3 years ago and never replaced. Even when employed it was improperly used. Evidently the question as to what readings the wash should start at and finish with, *i.e.*, what the range of the attenuation should be, was never investigated. The rule-of-thumb method was adopted that fermentation should be deemed ended when the saccharometer reading remained constant for 3 days. The record of "20 or more typical distillations" sent by the Excise Committee shows that this rule was not always adhered to and frequently was a snare rather than a help. In one case at least the fermentation should have been stopped at the 11th day according to rule, and was allowed to run on to the 17th.

Employment of Saccharometer.

2. *Determination of completion of fermentation.*—The present method, *viz.*, observation of stoppage of bubbling and development of an alcoholic odour, is very misleading. Bubbling may last for a considerable time after the completion of the true fermentation owing to the setting in of a subsidiary or late fermentation which is practically decomposition. Moreover, the alcoholic odour will arise in quite the early stages of the fermentation. The whole question of the best initial gravity for the wash, the attenuation and end-point of fermentation for each sugar basis or mixture requires to be carefully worked out, but until this can be done regular daily observations with a saccharometer and thermometer should be made and recorded; and also the yield. A mass of details would thus be accumulated and the best conditions would gradually become apparent of themselves.

Completion of fermentation.

As regards the end-point, it is better to sacrifice the last degree or two of possible attenuation rather than keep the wash standing for an extra week,—better both from the point of view of time saved and damage avoided to the spirit already produced. The speed of attenuation will always vary according to the activity of the yeasts and to the temperature. But if the hint given in a later paragraph (on æration) is followed the alteration in the rate of the attenuation will be found to give far more definite indications of the end-point than in the cases recorded in the Excise Committee's notes.

In the matter of temperature the native distiller is quite dependent on natural conditions, but careful temperature observations will enable him to anticipate what is going to happen.

Non-æration of wash.

3. *Non-æration of the wash.*—Another cause of protracted fermentation is the absence of adequate æration of the wash. If the fermenting vessels are small with narrow necks sufficient air will not be able to enter, and the carbonic acid gas produced during fermentation will be unable to escape, thus gradually poisoning the yeast and retarding and finally stopping its action. In order to avoid this state of matters the wash should either be stirred well or poured backwards and forwards.

Fermenting vessel.

4. *Size and form of Fermenting vessels*—As regards the relative advantages of small and large jars there is a conceivable advantage in keeping a wash prepared by the haphazard method used in native distilleries in smaller rather than in larger portions so that if some potfuls of wash went wrong a smaller bulk might be sacrificed. But no attempt whatever is made to examine the quality of the fermented wash, and it is distilled on (so called) "completion of fermentation" irrespective of its condition.*

As regards the form of fermenting vessels.—From the figures submitted it appears that fermentation was slower in the four large jars than in the eight smaller ones. Evidently this was due to inferior æration in the large jars, their mouths being narrower in relation to their capacity than those of the small jars. The area of the mouth (aperture for æration) varies as the square of its radius; the capacity of the more or less spherical body as the cube of its own radius. This of itself indicates that the form of the jars might be improved by enlarging the mouth of all the jars.

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* In Mr. Buckland's letter of 30th December 1886, it is stated that certain vendors consider that they can easily evade any rule limiting the size of fermenting vessels by putting more materials and less water into the vessels. The reply to this is that they would thus largely defeat their object through insufficient dilution of the Wash leading to deficient fermentation and lowered alcoholic strength.

The use of narrow-mouthed jars is stated to be justified by experience from time immemorial on account of its preventing the wort from becoming sour. This statement requires modification for the wort is always sour when over-fermented and contaminated by every chance micro-organism that may find its way into it. With clean fermentation, large mouthed jars could be safely used without souring and the fermentation-rapidity not retarded as at present.

Large vessels with wide mouths (in other words *vats*) are known by experience to be the most efficient form of fermenting vessel, when other conditions (*e.g.*, clean fermentation) are also introduced.

The use of large vats presents no difficulties in well managed Indian distilleries, and there appears to be no reason why they should not be widely introduced. The initial cost is, of course, greater than that of earthen jars, but the waste arising from the employment of the latter through frothing over of the wort as well as the production of sour liquor would tend to be done away with if proper vats were to be employed.

Vats, open or with a lid raised two or three inches from the vat's top to allow of the escape of the gas, would greatly reduce loss of time and saccharine matter. Stirrers driven by hand or otherwise could easily be added.

5. *Dilution of wash* has already been discussed under the head of "Time of Fermentation."

Conclusions.

The results of the investigation made in 1886 for the Bengal Board of Revenue by Babu Obhoy Chandra Das on the fermentation of country liquors were elucidated and added to by my predecessor, the late Lieutenant-Colonel Warden, who pointed out that the available-sugar had not been estimated before starting the fermentations, thus making practical deductions from the experiments impossible. Practically the only useful fact that emerged from the whole of this work was one as to the concentration of the wash. The results indicated that only a fairly large yield of alcohol was obtained when at least 4 parts of liquid to 1 of original sugar base was employed. Even this was not new information, as Colonel Warden in his Report quoted a standard publication (Watts's "Dictionary of Chemistry") to the effect that "fermentation can only take place when the wash is sufficiently diluted ; . . . . with less than 4 parts of water to 1 part of sugar it takes place imperfectly or not at all."

The Board circulated the reports, and some of the distilleries either were in line on this point or later came into line. Now, however, 20 *years later*, I find from returns furnished to me that 5 out of 17 distilleries in Bengal use too concentrated a wash (excluding the now closed-down rice distilleries in Orissa); whilst 33 distilleries outside Bengal err greatly in this respect, with the natural consequence that enormous waste of material occurs.

It may be urged that waste for so many years on the part of the manufacturers is no concern of Government's, still the Bengal Revenue Board explicitly state that they circulated these reports partly in the interest of the Abkars.

Government, however, is directly concerned in the matter in this way. The Excise Commissioner of Eastern Bengal and Assam finds the yield of spirit of Dacca higher than the general average elsewhere, and unless this can be satisfactorily explained contemplates holding a strict enquiry into the matter. Then the subject with all its past history occupies the attention of the Excise Committee and later of myself, all of us being already fully occupied with other matters, and only accidentally available for purposes of reference at this time.

It is therefore evident—

(1) that fuller information might have been obtained in 1886 if the work had been carried out by a *single* specialised agency ;

(2) that such information should be made available for other parts of India in order to save industrial waste and in the interests of Revenue Control, and,

(3) that the services of an expert authority should be made available.

CHAPTER XVII.

SOME NOTES ON THE UTILIZATION OF INDUSTRIAL SPIRITS AND DISTILLERY WASTE-PRODUCTS IN INDIA.

The following notes were made at the request of the Excise Committee and may be here conveniently reproduced.

I have had neither time nor opportunity to devote myself to this part of the subject in any special manner. It is also somewhat beyond the range of my deputation.

The Department of Commerce and Industry, Government of India, inform me that the present chief industrial uses of alcohol are—

Present uses in India for industrial spirits —

> "(1) the preparation of soaps, varnishes and paints, and of shellac by secret process in one or two factories; and
>
> (2) use as fuel in lamps and motors."

The first division of these calls for no comment, but the second is one of the chief and most promising directions for development of the industry.

Referring to the practical monopoly in petrol which has raised its price, Mr. Filson Young, who is a recognised authority on the subject, writes :*—

"The movement in favour of using alcohol instead of petrol needs only to be helped by a slight alteration in the Excise laws to make the whole matter a very much simpler one, and to put the motor industry on a much sounder basis than it enjoys at present. Alcohol could be cheaply produced in this country and Ireland; it is bulk for bulk a more powerful motive agent than petrol, and it is cleaner and simpler in its action."

I may also quote an extract from a letter, from one of the largest firms of Engineers and Contractors in Bombay, on this part of the subject :—

"As for the employment of alcohol for industrial purposes, there is no doubt that the motor trade, which is so largely expanding in other countries, has been greatly interfered with by the impossibility of using alcohol instead of benzine and petrol as fuel in this country.† In Germany, for instance, the running of a motor car and other motors using spirits does not cost a quarter to work them as it does in this country. Not only is the present price of alcohol prohibitive, but the quality of methylated spirit in this country makes it absolutely unfit for use as fuel for motors. From our own experience we believe we are justified if we predict that if Government would only help the trade to use alcohol instead of benzine and petrol, for industrial purposes, the demand for power motors of every description would instantly grow to an almost unlimited extent."

Use in motors and present obstacles to extension of its use in India.

"Our own fan business has been greatly hampered on account of no proper methylated spirit being obtainable anywhere in this country. This is the only suitable fuel for this machine; and to show to what an extent this business and all other motor business would grow, we may state that, notwithstanding the difficulties encountered in this country with fuel to satisfactorily drive our fan over 500 have been sold within the first few months of introduction. With the better spirit which would secure a still greater efficiency of the fan, combined with a lower selling price which a large demand would assure, there is no doubt that motor fans would be used in every better class house in India."

"There are thousands of petrol and kerosine engines running in this country, and the use of alcohol of the quality and at the price sold in other countries would not only work these machines much cheaper but also more efficiently, and hundreds of small factories and trades who, up to date, have shrunk from utilizing other than manual power, would soon realize the great advantage of using spirit motors. Small industrial workshops would immediately spring up, and expand with the appearance of a small efficient and cheap power motor, and this we believe cannot be doubted."

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* "The Complete Motorist," page 298.

† *i.e.*, India.

I have obtained, for experiment, the loan of a motor-fan (called a "radio-fan") which is a hot air motor driven by spirit. The spirit used must be pure so that complete combustion may be effected and a sufficient heat obtained, with no fouling of the wick and cylinder by deposit or corrosion. This would apply to internal combustion motors (as in motor cars) as well as to "hot-air" motors.

Up to the present, these conditions have not been met by the denaturalized spirit in use in India as is borne out by the following extract from another letter from the firm above referred to :—

Desiderata for industrial spirit.—

"Industrial methylated spirit should—

"burn without smoke ;

"burn without smell ;

"leave no residue in the wick ;

"leave no residue in the container ;

"leave no residue in an engine cylinder."

Disadvantages of present denatured spirit in India.—

"The disadvantages of methylated spirit as at present sold in India are that it—

"burns with an objectionable smell ;

"burns with an undesirable smoke ;

"clogs the wick after use for some hours ;

"leaves a clear liquid in the lamp container."

"Methylated spirit should be sold at a price at or below that of petrol."

"Of the denaturing agents at present used, wood naphtha is undoubtedly the best, being far ahead of the mineral naphtha, *but still it leaves much to be desired.*"

The Government of India have directed me to report on the subject of improving the denaturalization of spirit, and I have succeeded in obtaining a denaturant which I hope may minimize the disadvantages attendant on the use of such agents and which, at the same time, will much more effectively protect Revenue interests in this connection.

I entirely endorse the view that Government can do a great deal to foster and encourage the development of the industrial spirit trade in India ; and this question of a suitable denaturant is one of the most important of the means at their disposal for this purpose. The motor industry in all its branches is one then of special importance and hopefulness as regards the extension of the trade in industrial alcohol.

Heating and lighting by spirit.—

Heating and lighting are other important applications of industrial alcohol. I have obtained, from London, samples of incandescent-mantle spirit lamps and have had them in constant use in this laboratory with excellent results. The light given is strong and white, and the cost of burning such lamps is relatively small. Their superiority over kerosine, coal gas and electricity is, in my opinion, marked, and I consider that if their advantages were brought more to the notice of the public in India (other than, of course, the poorest classes) a large trade would spring up with a correspondingly great demand for industrial spirit. I am at present burning continuously in these lamps spirit treated with the denaturant I have devised, and hope shortly to report the results. Mr. Todhunter, in the useful note he has prepared for the Excise Committee on the subject, has detailed a number of domestic applications of heating by spirit. Its use in this relation can, of course, only be expected to be adopted among the wealthier classes who employ the domestic devices specified by him.

Vinegar manufacture, etc.

I have often thought that a large vinegar manufacturing industry might be readily developed in India with its plentiful and cheap sources of fermentative bases for spirits. And no doubt there might be an opening in certain parts of India for the manufacture of essences and perfumes which nearly all require spirit as their basis. Mr. Todhunter specifies as other possible industries dependent largely on the use of industrial alcohol the rubber, celluloid, pegamoid, photographic plates and papers. My only comment on this is that celluloid and rubber are exceedingly difficult substances to keep without deterioration in hot climates. I have had at times celluloid instrument-scales, &c., sent to me on account of this, and I have found a total disintegration had occurred with the separation of camphor in large flakes. Manufactured rubber is notoriously difficult to preserve or store in the tropics, and I confess I am not sanguine as to the chances of any considerable development in this direction for some time to come, or until these difficulties are overcome by fresh discoveries.

Refining oils.

Mr. Todhunter also mentions as a further possible industry "Refining oils," which might be developed in India to some extent as so many of the oil-bases are produced in this country; and here industrial spirit would have a large application.

Drugs.

No doubt also, with proper arrangement and under skilled supervision, a large number of medicines requiring the use of alcohol in their preparation could be made in India at a great saving to Government. What is required is a small staff of thoroughly-competent pharmacists, with sufficient manufacturing experience, to supervise their production.

Cordite.

With regard to explosives and acetone (for cordite) manufacture there is no reason why Indian-made industrial spirit should not be entirely employed for this purpose. This also would effect a considerable saving to Government.

Yeast for Baking.

The supply later on of yeast suitable for bakeries and for domestic use, as well as the yeast for the spirit industries is certainly also to be considered as a profitable side industry for distilleries. I am firmly convinced that in a country like India it seems necessary for Government to render relatively more assistance in the matter of developing and fostering industries than is the case in European countries. To do so is not only to help to make the country more prosperous but in various ways to largely add to Revenue. So in the case of yeast culture, I recommend that Government give the start to this branch of the industry, by supplying it from a department of such a central establishment (as I have elsewhere recommended) where it could easily be prepared. Later, when distilleries are sufficiently self-supporting as regards yeast, its production by a Government agency could be discontinued.

Distillery Waste products.—Mahua as a human and cattle food; and for manuring; and refuse *gur* for tobacco curing are well known applications of waste products. *Mahua* is stated to be unsuitable for feeding milch-cows as it tastes the milk and disagrees with infants and delicate people. Carbonic acid gas manufacture is already being conducted at several Indian distilleries (*e.g.*, Nellikuppam, Sujanpur, &c.) under European management, and there is no reason why a great extension of this business should not occur in connection with the contemplated centralized and modernised distillery scheme.

Distillery waste-products in India,

The other products of the *mahua* tree (*mahua*-butter, nuts, timber, &c.) need only be mentioned as illustrating the inducements which appear to exist for capitalists and others to make much more use of this tree's products for industrial purposes than is done at present.

And in the United Kingdom, etc.

I have been able to obtain only very scanty information from the United Kingdom on the subject of the use of distillery waste-products. The manager of one of the largest distillery companies in Scotland informs me that, as regards the malt and grain refuses from his distilleries, the "draff" (or refuse from the wort left in the mash-tuns) is carted away by cow-feeders who either feed their cattle on it fresh; or dry it for sale for a like purpose. The dry "draff" readily fetches £5 a ton. Pig-feeders cart away the thick part of the spent wash, and it forms an excellent food for pigs. Some distilleries drain their spent wash through coarse filters, and dry the solids, which also fetches £5 a ton, but here the cost of coal is a serious drawback at home. But in India, not only is fuel cheaper, but drying in the sun is of wide application at most seasons. No other waste products are used in England, so far as I could learn, except fusel oil, which is readily obtained in working patent stills, and for which there is a large demand. It is the basis for a valuable solvent used in many industries, more especially in the form of amyl acetate for resins, paints, varnishes, &c. The manufacture of potassium salts in Germany from the ashes of refuse is a very paying industry. Other possible applications could no doubt be found, and it would be to the advantage of all concerned that Government should help in the development of the

Conclusions.

great industrial resources of India in this direction by means of its experts and especially by giving selected officers the opportunity of studying, on the Continent of Europe, existing industrial applications, and the possibility of developing and modifying these to Indian requirements. Without such assistance in this country private enterprise is not likely to produce any marked industrial development in this direction. The cheapness of the reform suggested should, however, be a strong inducement to Government to undertake such measures, in the interests of a future increase of Revenue and in order to foster what is likely to become an important industry.

F.

CONCLUDING SECTIONS.

Chapter XVIII.—Proposals for the technical instruction of Excise officials and of distillers.

Chapter XIX.—Proposals as to systematic expert control of Excise technical operations.

Chapter XX.—Summary of foregoing Sections and Conclusions.

CHAPTER XVIII.

PROPOSALS FOR THE TECHNICAL INSTRUCTION OF EXCISE OFFICIALS AND OF DISTILLERS.

Necessity for technical instruction.

Granted that a centralised and modernised distillery scheme would not only lead to the production of more wholesome liquor but would also be more controllable for excise purposes and would offer less chance of defrauding the revenue than the system of smaller outlying and ill-controlled distilleries which at present obtains so widely, the question of the improvement of the *personnel* connected with distilleries at once becomes of prime importance. The distiller obviously should know his business (which at present in native distilleries he generally does not) so as to be able to produce a good quality of liquor under economically advantageous conditions. There would appear to be no reason why distillers should not be eligible for courses of technical instruction in India equally, and side by side, with excise officials. But the ultimate control lies with the latter, and so their instruction becomes essential in the interests of the protection of the revenue from spirits and the production of wholesome liquor. If any attempt is to be made to improve native methods of spirit manufacture, the most hopeful way would appear to be to give the excise officers in charge of distilleries the necessary elementary technical instruction in the control of distillery work with special reference to supervising the simple methods necessary to improve the working of existing native processes. Native distillers also would soon learn how to conduct spirit manufacture on rational lines and the improvement in quantity and quality of the outturn would be speedily apparent. At present it would be difficult to over-estimate the degree of ignorance of their technical duties which prevails among excise subordinates in charge of distilleries. This is not their fault for (except in Madras) no attempt is made to give them the requisite instruction. One of the first steps towards effecting any improvement of distilleries is, then, the elementary instruction of excise officials in distillery control. I shall elsewhere fully detail the nature of the simple technical, theoretical and practical instruction of the excise officers in charge of distilleries that is necessary if Government desire to effect any improvement in the control of Indian distillery operations.

A Central Distillery School essential.

The provision of a central distillery school is the first essential. To it might be attached a workshop for the outturn (at much less cost than at present) of excise safes, threeway cocks, &c., as well as of any other standard plant that may be adopted for use. In the school, excise men should be taught the law and excise rules relating to the subject; the practice of gauging and other excise operations generally, and the points at which difficulties may arise and the means of obviating these; the means of controlling efficiently and intelligently technical distillery operations in general so as to prevent fraud to the Revenue and deterioration of the spirit's quality, &c. In addition, this school (or better still the Excise Laboratory associated with it) might well and easily be made a centre for the supply (on payment) of pure yeast to distillers all over India. This at any rate might be so until distilleries can be self-supporting in this respect, which is not likely to be the case for some years to come. There is a great deal to do in the way of ascertaining alcoholic yields from washes made from different fermentative bases and of determining the best conditions for working various materials and yeasts, so that the school might further be made a centre for technical inquiries connected with excise administration generally; as well as serving as a means of fostering intelligent and progressive methods in the industries closely associated with excise administration. I may add that many technical difficulties confront the distiller before he can work *mahua* on a large *industrial* scale, such as the most suitable yeasts to use and the best methods of mashing, fermenting and distilling the washes. With Government assistance, a large industrial spirit trade might be fostered and this would also increase the revenue from spirits not only in a very unobjectionable, but in an industrially advantageous, direction.

A sound yeast supply necessary.

I would suggest that this distillery school should be a central one rather than that each Province should be provided with a separate small school. It would be better and certainly will be much cheaper to have one good central school efficiently staffed and having proper appliances for practical teaching, as well as the workshops referred to and other necessary accessories for experimental technological work.

Expert Distillery Inspectors required.

It is not sufficient merely to train distillers and Excise men in the proper methods to be employed in their work but it is, of course, equally necessary to see that they give practical effect to their training and this can only be done by regular *expert* inspection. The best way to ensure this is to engage from home at least two *practical distillers* who after a course of instruction in India in Excise Regulations and special methods of control would be occupied in touring round distilleries in order to demonstrate practically in what manner effect was to be given to the technological reforms required. We need for this purpose thoroughly practical men who have been educated *as practical distillers* and who have a thorough working knowledge of the technical requirements of the business.

One of these officers might be required to assist in conducting the courses of practical instruction in distillery management and excise operations, say, for a few weeks twice a year, to a class of excise subordinates; and arrangements could be made to concurrently provide for tuition in those necessary practical applications of science to the control of distillery and excise work by a member of the staff of a Central Excise Laboratory.

Distillery School Course.

By means of small and inexpensively-constructed working models every stage of distillery processes could be illustrated, and this would be much better than attempting to utilise any existing distillery for the purpose.

I do not recommend that the school should be made a centre for standardisation and issue of hydrometers, saccharometers, &c., as it would not be continuously working while the requirements of the Excise service would demand no delay in the issue of standardised instruments. For this reason, I recommend that this work be undertaken at a Central Excise Laboratory which would be at work all the year round.

Here also yeast-culture on an industrial scale can be carried on uninterruptedly throughout the year, as already explained.

Distillery School Course.

Theoretical Section.

First as regards *the theoretical portion of such a course,* I have already suggested to Government that I should write a "short practical manual for Excise use," and this proposal has been approved. The book which would have to be extended considerably beyond its original proposed scope, would chiefly deal with the subjects mentioned at Appendix A (I Theoretical (1), (2) and (3)). It would be supplemented at the school by oral instruction and demonstrations by an Excise expert as to the practical technical work referred to and which might be suitably extended as necessary. Also Indian Excise Law and Regulations could be taught.

The Practical Course.

Practical Section.

The practice of distillery operations (Madras course* (5)) should be conducted by the Excise expert along with one of the staff of a Central Excise Laboratory who would teach the subjects specified under the Madras headings (1) and (6). The mistake should not be made of making the chemist the teacher of practical Excise operations or, *per contra,* the Excise and distillery expert the instructor in the chemical and scientific subjects. It is unreasonable to expect to find the necessary practical expert knowledge on both groups of subjects combined in officers of the description above referred to. This is, in my opinion, the mistake that Madras makes in its present arrangement. The teacher of the practical details of Excise work cannot be at the same time an Inspector of Distilleries and Excise operations as well as an expert chemist. And, at the outset, it is necessary to provide the school with the best procurable practical expert management and teachers. Otherwise, it is likely to fail to accomplish its object. The teaching in each division of the course should therefore be conducted by practical men who are daily engaged in the conduct in the one case of Excise chemical work, and, in the other, of inspection and other work connected with practical Excise Administration.

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* The Madras Distillery School Rules are appended to this chapter.

Duration, &c., of Course.

The course of instruction might last (as in Madras) for six weeks, and two courses a year might be held to begin with, at any rate. I have already suggested that the school might be utilised as a centre for technical enquiries connected with distillery or other Excise questions (including salt). Though Commissions and Committees as well as Provincial Excise Commissioners have repeatedly urged the necessity for such enquiries as, *e.g.*, that into the average alcoholic yield from different fermentative bases and into the most suitable conditions for manufacture, no definite advance has yet been made. The Dacca experiments (*see* Chapter XVI) clearly indicate the inadvisability of utilising the services of untrained Excise men for such enquiries. The most obvious preliminary step was in this case omitted, and the result has naturally been unsatisfactory.

Sanction has within the last year or two been asked by different Provinces for the employment of a technical expert, but at present (except in Madras) there is no recognised expert agency to assist the Excise Administration in India.

As regards the staff of the Distillery School, the two teachers would be employed in the intervals between the classes as follows :—

Distillery School Staff.

The Excise distillery expert would tour round distilleries or be otherwise engaged in practical Excise work; and the chemical teacher would be a member of the staff of a Central Excise Laboratory, to the work of which he would return between the classes.

The workshop staff might consist of an experienced European mechanic recruited either in India or England and two or three "mistris" who could be trained by him as was requisite. In addition, there would be two or three menial servants to keep the school premises and plant secure and clean, &c. It will be seen from the above that the cost of maintenance of such a school would be nominal, as the teaching staff would be employed elsewhere as well, and in addition the workshop would effect a marked saving in the price of the articles turned out and which at present are relatively very costly.

It is thus obvious that a central establishment, such as above indicated, would be much more economical than one in each Province, and that an excellent practical teaching staff could be available for it at practically no extra cost to Government.

As regards the distillery experts, it would suffice meanwhile to appoint (on probation) two experienced practical distillers, from Home—one for Bengal, Assam and the United Provinces, and another for the Punjab, Bombay and Central Provinces. The officer detailed to the proposed Punjab, Bombay and Central Provinces' Circle might be selected as the teacher at the Distillery School. The usefulness of practical expert inspectors in distillery and other Excise work, especially during any transitional period as from the present to more modernised and, technically, more highly evolved conditions, is surely sufficiently manifest. And one need only further cite the admitted gain that has followed the appointment in Madras of a technical expert as Abkari Deputy Commissioner.

APPENDIX TO CHAPTER XVIII.

THE MADRAS DISTILLERY SCHOOL RULES.

The school will be under the sole control of the Deputy Commissioner of Abkari. The instruction will consist of a course of lectures on distillery and brewery practice with chemical demonstrations illustrating the subject matter of the lectures and a complete practical course at an adjoining distillery.

Madras Distillery School Rules.

2. The school shall be held at the Madras Depôt Circle from ......on which date the officers selected will present themselves before the Deputy Commissioner of Abkari.

3. In case of wilful inattention to the course of instruction the Abkari Deputy Commissioner will report the officer to the Board, submitting at the same time his explanation, and in the case of incapacity to profit by the course the Deputy Commissioner may remand the officer found incapable to ordinary duty, requesting at the same time the Deputy Commissioner of the Division from which he has come to arrange to provide him with an appointment. If it is not too late in the course his place should be taken by another officer.

4. No leave except on medical certificate or upon urgent private affairs will be granted to any officer during the course. The Abkari Deputy Commissioner will decide the question of urgency should it arise.

Sundays and official holidays will be kept.

5. Officers should reside within a reasonable distance of the building where the classes are held and will register their addresses in a book kept for the purpose. They must not leave the neighbourhood without the sanction of the Akbari Deputy Commissioner.

6. A record of attendance will be kept which will be signed by each officer on each occasion of his attending the class.

7. The course of instruction will last for about six weeks and will close with a written examination. It will comprise the following subjects :—

Syllabus of Madras Course.

I.—Theoretical.

(1) Elementary Chemistry :—
  (*a*) Definitions, nomenclature, atomic and molecular weights.
  (*b*) Carbon compounds—sugars and alcohols.
  (*c*) Compounds required in the analysis of sugars, etc.
  (*d*) Decimal weights and measures.

(2) Mensuration of solids :—
  (*a*) Areas.
  (*b*) Capacities as applied to the gauging of vessels of various shapes.

(3) Technical distillation and brewing :—
  (*a*) Materials.
  (*b*) Ferments and fermentation.

Action of ferments on—
    (*i*) Saccharine solutions.
    (*ii*) Malt wort.

  (*c*) Attenuation and distillation.
  (*d*) Spirit and spirit values.
  (*e*) Saccharometers and hydrometers.

(4) Excise Manual as far as it relates to Distillery and Warehouse rules.

II.—Practical.

(5) Distillery :—
  (*a*) Distillery course throughout, with special reference to the fermentation and attenuation of wash, the quantity and outturn of spirits, and the by-products.
  (*b*) Revenue checks. Purpose and application of—
  (*c*) Accounts.

(6) Chemistry.—

(*a*) Analysis of sugars :—

- (*i*) Inversion of cane into grape sugar.
- (*ii*) Determination of sugar values.

(*b*) Estimation of spirit values.

(*c*) Obscuration of spirit values.

(*d*) Blending and reducing of spirits.

(*e*) Determination of original gravity of wash.

(*f*) Methylation.

(*g*) Microscopic examination of matters used in distillation, etc., including starches, yeast, healthy and harmful ferments.

Method.—The theoretical subjects will be dealt with as far as practicable so as to keep pace with the practical demonstration.

8. *Hours.*—Classes will be held at such hours as the Abkari Deputy Commissioner may fix, and will generally occupy two hours in the morning and two in the afternoon.

9. At the conclusion of the course an examination will be held by the Abkari Deputy Commissioner, and a report on the extent to which each officer has availed himself of his opportunities for learning distillery work will be submitted to the Board and the Deputy Commissioner of the Division.

CHAPTER XIX.

PROPOSALS AS TO SYSTEMATIC EXPERT CONTROL OF EXCISE TECHNICAL OPERATIONS.

Improvement, not abolition, of existing distilleries is needed.

I have endeavoured to show in previous chapters that the substitution of large modern distilleries employing chiefly patent-stills, which would have the effect of introducing the capitalist at the expense of the existing class of spirit-manufacturer, is unnecessary for the production of wholesome potable spirits which will "keep and carry." All the essentials of reform can be secured by continuing the existing system in modified form : in other words evolution, not revolution, is indicated.

Essentials for improvement of distilleries in India.

To accomplish this existing distilleries should be—

(1) much more centralized so as to ensure greater Excise control in every respect;

(2) proper technical instruction in an Excise Distillery school (and preferably "certification") is essential for the distiller ; and

(3) for the Excise Distillery superintending staff;

(4) combined with frequent *expert* inspection of distilleries (as by the special inspectors to whom I have formerly referred). On this would certainly follow production of a good and wholesome spirit on economically advantageous lines.

The whole of the modern fermentation industries have arisen, and have been worked at, in temperate climates. The practical results of this industrial and research work are controlled for Revenue purposes, in every civilised country, by large and well-equipped Government laboratories. The only attempt in India to follow suit in this obviously very important matter is the establishment of a small Excise Laboratory in Madras.

The question first arises,—Has the Madras Excise Laboratory justified its existence? The Madras Board of Revenue in their Dis. No. 118, dated 22nd January 1906, wrote :—

"The Board, has no hesitation in saying that the Laboratory has fully justified its existence . . . It was established with a view . . . to assisting the Board in the control of the revenue and the carrying out of its rules and regulations, especially with regard to the quality of excised articles. The work has, however, gradually increased and, while experimental work is still conducted where new points arise, the bulk of its contents of routine work deals with both salt and liquor.

Madras Board of Revenue's estimate of usefulness of their Excise Laboratory.

"It will readily be seen that the value of the Laboratory to the Board cannot be assessed in figures. It supplies a want which must be felt in any department dealing with manufactures in which chemical processes are involved. By its means these processes can be controlled, if necessary, and in all cases can be intelligently regulated. The advantage . . . cannot be too highly estimated, and the Board in concluding would point out that the wisdom of establishing the Laboratory has been most thoroughly proved."

The nature of the work done in the Madras Laboratory is fully detailed in the Appendix to this chapter. As regards this list, it must be borne in mind that a Central Excise Laboratory would be required to undertake many other enquiries and routine duties of the nature of which Government are already well aware. It seems needless to enter into further detail, for the necessity of such a Laboratory has been fully recognised by recent Excise authorities in India, and without such expert assistance any scheme of improved Excise control would be impossible.*

Certain conditions essential for reliable Excise Laboratory work in India.

It is urgently necessary that the modifications of temperate climate processes requisite for the very altered conditions obtaining in India should be thoroughly ascertained. Till the present—and then only incidentally in the course of this investigation—no attempt has been made to do so, and we are still only on the threshold of this subject so essential both to Excise control and industrial development. Such a Laboratory must start under the well-understood conditions that prevail in temperate climates (hence the necessity for a hill site) and gradually work out the effects of tropical conditions.

Chemical and technological help necessary in any scheme of improvement.

Ascertainment of alcoholic yields.

The distillery industry and Excise technical operations are closely dependent on scientific help and control if they are to be efficient, as the processes employed are primarily and essentially based on scientific knowledge. Granted, then, that it is decided to improve and centralise existing distilleries, one of the first necessities is to ascertain the limits of alcoholic yield from the various fermentative bases. This has never been done in India hitherto on proper lines *and the new conditions of manufacture in a tropical climate make the work one of the first necessities* in the interests of Excise control and industrial advantage. The yields from *mahua*, *gur*, mixtures of these two, rice, toddy, etc., first require to be ascertained, under proper working conditions. The Dacca Distillery case has already furnished us with an example of the futility of entrusting such enquiries to untrained Excise officials. No proper attempt to obtain even the most elementary knowledge of this nature has yet been made in India. Therefore, one of the earliest enquiries to be made by an Excise Laboratory staff would be this and it would involve—

Chemical analyses and fermentation work requisite in control of distillery work.

(*a*) the chemical analysis of the various fermentative bases in order to ascertain the alcoholic yield that may be expected from them ;

(*b*) practical fermentation experiments on rational lines, employing sound and suitable yeasts (instead of the haphazard and unbusiness-like method of chance infection as at present) with proper plant and conditions of reasonable cleanliness of premises, etc. ;

(*c*) systematic analyses of the resulting spirit in order to make sure that those defects which are so pronounced in country spirits at present have been removed.

Provision of sound yeast from a suitable centre is an essential to improved fermentation methods.

Without the provision of sound yeast the fermentation process will always be very wasteful and dangerous. Chance infections of the wash by other organisms are invited by such haphazard and crude methods as at present obtain. It is useless to expect the spirit industry in India to overcome this difficulty unaided. What is found in even many European managed concerns in India is that careless methods gradually supervene and that the conditions of manufacture are, in many cases, radically bad and wasteful in consequence. If any improvement is desired, Government must help by providing some centre from which pure sound yeast can be obtained. If this part of any improvement scheme be omitted control of fermentation becomes impossible as the stray yeasts at present trusted to produce fermentation are, and must continue to be, badly contaminated with acid-forming and other most undesirable and waste-producing organisms. My advice as to this most important detail is that steps should be taken at as early a date as possible to procure a European trained chemical assistant who has specially familiarised himself with all the details of yeast-growth on an industrial scale. I am prepared to submit the name of a suitable man whose services could be secured for £250—25—300 per annum. If this proposal is adopted this man ought to be placed on special duty in London for three months at certain yeast-growing establishments which I am ready to specify, so that he may be prepared to start yeast culture in India under the best and most modern conditions.

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* Foot-note.—" One final necessity, in the Committee's opinion, in either case is that of an expert adviser to the Excise Department."

" It is clear that if present distillery methods are pursued some action must be taken to check the issue of very impure spirit and this can only be done, if some expert adviser is available to thoroughly investigate the processes of distillation and analyse the results."

" On the other hand if patent-stills and improved processes are introduced this Department will stand in sad need of some technical referee who will understand them. The absence of any such adviser has resulted in more than one instance in the prohibition with the best intentions of processes which are not only harmless but necessary and beneficial."

" They would therefore strongly recommend that a technical adviser be appointed, not necessarily to this Government alone, in the interest of the trade as much as in that of Government."

Central Provinces' Excise Committee's Report, 1904 (pages 56-57).

A member of Excise chemical laboratory staff should be trained as a yeast expert.

The yeast-growing plant ought to be set up in a cool climate for the reasons already stated and this could readily be arranged at Kasauli. In this way, in a comparatively short time from now, we could arrange to supply Indian distilleries with sound yeast the use of which, *under the improved conditions of manufacture*, would result in a much larger alcoholic outturn than at present and of much more wholesome quality in general.

Pure yeast culture can only be undertaken in a suitable climate.

Further work could be carried on here with different types of yeast in order that the types most suited to the different Indian fermentative bases and special conditions of manufacture could be obtained.

Most suitable kinds of yeast should be ascertained.

It must be evident, as the results of my recent enquiries clearly show, that a careful scrutiny of the existing technical methods used in Excise work is very urgently needed. The condition of affairs could scarcely be more unsatisfactory than at present. We find in general—

(1) The use of inaccurate hydrometers and though numerous regulations exist for checking their accuracy yet the practical result is extremely unsatisfactory, and very wasteful of revenue. It is essential that some central scientific agency such as an Excise Laboratory should undertake once for all the standardisation of hydrometers, saccharometers and their thermometers and *that by its agency a regular system of periodic-re-standardisation should be conducted.* As soon as the question of fixed issue-strengths is decided, suitable and economical *standard patterns* of hydrometers should be devised, standardised and issued. The waste of public money by the use in general of *unnecessarily* costly and frequently very inaccurate instruments in India at present is a serious matter and one that clearly requires to be set right as soon as possible.

Urgent need for proper systematic standardisation of excise hydrometers, etc.

(2) The large losses of revenue from acid-obscuration have apparently been overlooked until the present. At least, nothing has ever been attempted in the way of preventing such losses. This has been chiefly due to the fact that there has been no agency available till now for the examination of such matters. The costliness of such omission must be sufficiently obvious (*e.g.*, see my previous remarks on obscuration). It is thus necessary that the present acid obscuration-losses to revenue should cease as soon as possible and, as I have already pointed out, the easiest and most effectual way to bring this about is to improve manufacture so as to prevent the formation of high degrees of acidity. Casking-obscuration can be dealt with by the means advised in the chapter on obscuration.

Obscuration in excise work.

(3) The subject of wastages from reduction and blending requires early attention, as a marked loss of revenue is involved by the present neglect of this matter. Simple and specific directions to Excise-men should be drawn up on the lines

Reduction and blending wastages.

mentioned in my note on the subject; and, in order to save delay and trouble and prevent miscalculations in excise work, as much as possible of these working directions should be issued in the form of tables. The note I drew up on the subject has been issued in the Bombay Presidency for the guidance of excise officials but it was never meant to be issued in this way as working-instructions and should be supplied in the form of specific directions and tables for ready calculation. The Bombay Government have since asked the Government of India to allow me to draw up such directions, and to compile tables and I have recently been directed to prepare such for use throughout India.

Evaporation-losses of spirit.

(4) The whole question of evaporation-losses of spirit in India requires careful examination. Many discrepancies occur from the want of information on this subject at present.

Dyes and flavouring essences.

(5) If "dyes" for spirits and opium are to be introduced and if flavouring essences also are to be used, a good deal of laboratory work will be required in order to devise suitable dyes and to draw up proper specifications for essences.

Analyses of fermented or spent-washes from distilleries.

(6) The analysis of fermented or spent-washes in cases where unsatisfactory results are being obtained in distilleries is another essential step towards securing the desired improvement of distillery operations.

Obscuration tables.

(7) The preparation of obscuration tables for excise use based on observations of average obscuration arising under the various conditions found in India (see chapter on obscuration) is another important matter for investigation at an early date.

Other special technical enquiries.

It is evident that, especially at the start of rational methods of spirit manufacture, many other special technical enquiries will inevitably be required. The Excise Committee have experienced the necessity for several such in the few months they have been engaged on their enquiry and it will thus be readily realised how essential it must be for Government to possess an agency to deal with such highly technical questions as are certain to arise. A consideration of the Madras Excise Laboratory's List of work will furnish further examples of the work which would be required from an Excise Laboratory established in Northern India.

Site of proposed Excise Laboratory.

As regards the site of such a Laboratory the following points should be borne in mind:—

The purpose of such a Laboratory would be the critical and authoritative examination and control of Excise technical processes and industrial operations. Such have been devised in, and verified for, temperate climates and are well known to be highly dependent for their accuracy on conditions of temperature. *They have been adopted in India without adequate knowledge of the influence of tropical conditions, and the sooner that such information is obtained the better for Excise Revenue and control.*

Reasons why a temperate climate is essential.

For the accurate investigation of such subjects, a temperate climate is an absolute necessity on account of—

(*a*) the frequent estimations and investigations connected with highly volatile liquids;

(*b*) the frequent examination of yeasts and of fermentative processes; and (*c*) the investigation of statements as to fact which will, in cases of dispute, be liable to comparisons made elsewhere under suitable climatic conditions for the proper determination of such facts.

The handicap, in many cases the impossibility, of working such operations under tropical conditions is thus self-evident. For such purposes as cited a comparatively low air temperature is essential so that the conditions may be readily reproduced under which the original information was obtained.

Dangers of conducting spirit enquiries under unsuitable conditions.

In Chapter VIII I have given proof of the dangers and inaccuracies that follow attempts to work out methods for spirit-control under tropical conditions. We have seen the recurring loss to Government that resulted in the instance given from the attempt to investigate such a subject under unsuitable conditions, since Colonel Warden was unable to eliminate high air-temperature conditions.

Yeast work also requires suitable conditions as regards temperature and purity of air.

As regards yeast work, to attempt such under plains' conditions would simply be to court failure. I have done work of a similar nature in Lahore and Calcutta and can thus speak from experience as to the great disadvantages, and in such work as is involved in pure yeast-growing the practical impossibility, of attempting such under tropical conditions. It is as well to bear in mind that a good deal of technical bacteriological work would be required in connection with yeast-culture and in the investigation of the fermentation-failures that are sure to occur from time to time. For such work, a suitable climate is a *sine quâ non.* It should be borne in mind that the Indian Imperial Bacteriologist's Laboratory was at first started at Poona but that it had later, at great expense, to be transferred to proper climatic conditions at the hill-site of Muktesar. Again, the Central Bacteriological Institute for India has naturally had to be placed in a hill-climate, at Kasauli.

On the ground of contamination during such frequent incidents as dust-storms and on account of the thickly germ-laden air in the rains any attempt to conduct proper yeast culture *on an industrial scale* in the plains would be ineffectual.

Suitability of existing site at Kasauli for continued work.

I know of no more suitable site than Kasauli for such work as I have referred to. Its closeness to Kalka and so to the great Railway systems that are connected with the latter render it specially easy of access. If, as suggested, a small Distillery school be placed at Kalka all the necessary conditions for practical distillery, and the associated laboratory, work will be fulfilled. *Many investigations and much of the work would at times have to be carried on conjointly* and the combination of conditons at Kalka and Kasauli would seem to be unmatched elsewhere in India.

Dehra Dun and Mussoorie have been suggested as alternatives. This would mean two laboratories instead of one (as at Kasauli)—one for use during most of the year alongside the Distillery school at Dehra and the other in Mussoorie during the hottest months during which Excise laboratory work could not be conducted at Dehra. The Kasauli-Kalka scheme seems preferable to this on most grounds.

Another important consideration is this :

Other considerations regarding side.

The European staff is one of specialists, limited as regards recruitment and replaceable with great difficulty, and should be employed where its services can be most efficiently and economically used and without constant interruptions to the work from sickness. It is impossible to obtain suitable substitutes for such work when emergencies arise, as can be done in the case of other services. It is further impossible to conduct work requiring the use of naked flames (and, therefore, without punkas) for several hours daily in a tropical climate such as that of the plains of India. The success of chemico-technological work largely depends on the European staff *actually doing the work themselves* and not merely supervising it from an office chair. Furthermore, the number of hours that work can be conducted in tropical heat is necessarily much less than in a less trying climate, and in chemical work continuity of work is all important.

I may cite the case of my present Laboratory at Kasauli. The work that has been done here (and which is practically the same as an Excise Laboratory would have to do) it would have been quite impossible to undertake in the plains (on this point Government has also had several of the most competent expert opinions from home); and ample evidence on this point has further accumulated during the course of the investigation into the various Excise questions dealt with here, and has been already referred to in this Report.

It may be objected that the Madras Excise Laboratory staff and all Chemical Examiners conduct their work under tropical conditions. *But certain classes of Excise chemical work could never be successfully attempted in a hot climate like Madras.* Besides a great deal of the Madras Laboratory work deals with salt, etc., as well as with alcohol. The Excise Laboratory there, besides, is not required to undertake investigations of the difficulty that have been undertaken by the Kasauli Laboratory or which would be required in the case of a future Excise Laboratory for practically the whole of India. Again, the work of Chemical Examiners is chiefly toxicological, and for such work tropical conditions are not specially disadvantageous, whereas for many Excise cases the opposite is the case. The use of ice is quite insufficient in many cases with which such a Laboratory frequently has to deal, so that the difficulty of high air-temperature cannot be nullified by this or other artificial means.

As regards the cost of maintenance of a Central Excise Laboratory, I have already estimated for this as follows :—

Estimated annual cost of a Central Excise Laboratory.

	Rs.
European Staff.	
Director ... ... — ...	18,000
1st Assistant (Rs. 650—50—875)	10,500
2nd Assistant	3,750
Native Staff.	
1st Laboratory Assistant	1,200
Clerk	960
2nd Laboratory Assistant (and 2nd Clerk)	360
Menial Establishment.	
3 Bearers	384
1 Chaprasi	120
1 Daftri	120
1 Bhisti	120
1 Sweeper	96
Rent and taxes	1,075
Chemicals and apparatus from England	4,000
Office expenses (water, heating, contingencies, chemicals from India).	3,600
Total annual cost ...	44,285

It has been considered by Government that this estimate is somewhat too low, and it has been pointed out that more than one clerk would be required. But the estimate of Rs. 45,000 per annum includes not one but two clerks, one of whom can also be employed as a 2nd Laboratory Assistant and is shown as such in the estimate. This arrangement has been and is now in force here and has worked admirably. I do not see any reason to alter my original estimate in any particular ; but in order to allow an ample margin for error, the amount may be increased by Rs. 5,000 which will bring up the total annual cost to half a lakh.

If Government prefers to adopt a tentative attitude with regard to this scheme, it would suffice to give a three years' preliminary trial to it and at the end of that time to decide as to whether or not it had justified its existence. In this time in any case a great many of the more urgent and difficult questions would have been worked out by it. So, as regards initial cost, the best plan would appear to be to continue to rent a house as a Laboratory as at present.

The saving of Excise revenue effected by the control exercised by such a Laboratory would be many times greater than the cost of the Laboratory, as, for example, by checks on obscuration, control of spirit-yields, evaporation and other wastages, " dyeing" of liquor and opium ; the issue for use of accurate hydrometers, etc., in addition to the conduct of those special Excise investigations which are so frequently necessary. Furthermore, by taking occasional "surprise" samples for analysis at the Laboratory, the quality of all outturned liquor in India could be controlled in a satisfactory manner.

Staff required to conduct proposed distillery reforms.

Leaving aside the question of Distillery Superintendents and of the better class of Excise officials in charge of bonded warehouses, the staff required for the conduct of the reforms necessary as regards distilleries in India may be thus briefly summarised :—

(1) A technological and chemical expert whose functions in relation to the various Excise administrations would be purely advisory. This officer would naturally be the Director of the proposed Central Excise Laboratory and Superintendent of the Central Distillery School.

(2) Inspector of Distilleries, Western Circle (*i.e.*, Bombay, Punjab and Central Provinces), and Instructor in Excise duties, etc., and in the Technology of Distillery manufactures at the Central Distillery School.

(3) Inspector of Distilleries, Eastern Circle (Bengal, Eastern Bengal and Assam, and United Provinces).

(4) Senior Chemical Assistant, Central Excise Laboratory, and Instructor in Chemico-technical duties at the Central Distillery School.

(5) Junior Chemical Assistant, Central Excise Laboratory, and in charge of yeast-culture and supply work.

(6) A European mechanic for Excise workshop, with two or three *mistris.**

(7) The Native staff already detailed as necessary for the Central Excise Laboratory.

(8) Two or three menial servants for employment at the Central Distillery School.

APPENDIX TO CHAPTER 19.

NATURE OF THE WORK DONE IN THE MADRAS LABORATORY.

I.—Experimental work.

(*i*) Examination of all substances used in the Presidency as ferments with a view to obtaining information regarding the fermentation of wash.

(*ii*) Experiments with a view to possible improvements in the methods employed in the manufacture of salt so as to obtain a purer and less wasteful article.

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* This establishment should be an adjunct to the Excise Laboratory so that proper supervision may be possible.

(*iii*) Attempts to find a reliable field test which shall assist the departmental officers in determining whether toddy in transport or in shops is true fermented toddy or a mixture of fermented and sweet toddy.

(*iv*) Any revenue details to which the aid of chemistry or microscopic examination would be applicable.

II.—Ordinary work.

1. Periodical examination of worts, brewers' grains and beer brewed in the Nilgiri breweries and of beer imported into the Presidency from Bangalore.

2. Analysis of—

(*i*) Samples of liquor submitted by local officers from distilleries and warehouses or from wholesale depôts when much discoloured or showing any abnormal fall in strength.

(*ii*) Samples of fermented or spent wash from distilleries when the outturn is unsatisfactory or variable.

(*iii*) Samples sent by traders in connection with contracts for supply of arrack.

(*iv*) Samples of essences to be used by distillers in the manufacture of "Country made foreign liquors" and determination of the proportions in which they must be used.

(*v*) Samples of materials such as hop substitute, carpulose, &c., proposed by brewers to be used in the manufacture of beer.

(*vi*) Samples of toddy residue submitted by departmental officers for the determination of the presence or absence of lime.

3. The analysis of samples of salt manufactured at all the factories in the Presidency.

4. Occasional analysis of nitrous earth, saltpetre, and of any substances which are likely to prove dangerous to the salt revenue.

5. Periodical examination and standardisation before issue of all thermometers, hydrometers, saccharometers, bungrods, &c., supplied to the officers of the department.

6. Examination and repair when possible of all instruments returned by officers as unserviceable or inaccurate.

7. Standardisation of prescribed measures supplied on purchase to all arrack shopkeepers.

8. Examination of confiscated opium.

9. Analyses of *ganja* and other intoxicating drugs, whenever necessary.

10. Obscuration test of samples of foreign liquor imported at all ports, including Madras, in the Presidency for the levy of duty.

CHAPTER XX.

SUMMARY OF FOREGOING SECTIONS AND CONCLUSIONS.

Preliminary comparative study of analytical methods, etc.

The preliminary difficulties connected with obtaining chemically pure substances for the investigation in its chemical, physiological and technological phases have been briefly indicated as also the results of the extensive series of comparative examinations of existing methods of spirit-analysis, etc.

Results of analysis of Indian liquors.

An exhaustive chemical investigation of the alcoholic liquors obtainable in India has had the result of showing that the different kinds of spirits made in India compare quite favourably with imported spirits of a much higher grade (as regards conditions of production and price), except in the two important particulars of acidity and furfural-content.

The remedy for these usually associated defects has been shown to lie in improved conditions of manufacture and the lines along which such reform should move have been indicated, and are summarised further on.

Cheap Imported spirits.

As regards cheap imported spirits their general characters have been defined and the opinion expressed that there is no evidence to indicate that they are of a specially deleterious nature.

Fermented Liquors.

The quality of Indian fermented liquors of all types has been examined. Toddy (*tari*) was found to possess in somewhat higher degree than the other types, a greater nutritive value in general with the associated advantage of relatively lower alcoholic strength.

The fact of the relative preponderance of certain by-products in fermented liquor is an accidental confirmation of my general conclusion concerning the negligibility as regards noxiousness of the amounts of by-products found in alcoholic liquors. There is a consensus of opinion in India, as well as in other countries, that fermented liquors are in general very much less harmful in their effects than spirits. Yet here we find that relatively larger amounts of by-products (except furfural) are being consumed by the drinker of fermented liquors than by the spirit-drinker in attaining the same dose of (ethyl) alcohol. This appears to point to the fact that the by-products are not to blame for the noxious effects of alcoholic liquors, but that it would appear to be chiefly a matter of the quantity of (absolute) alcohol consumed. In other words, spirit-drinking is more noxious because *the toxic amount of alcohol is more quickly reached and more easily exceeded.*

Non-deleteriousness of amounts of by-products present in liquors.

Standards and quality tests unnecessary.

The physiological section of the work has indicated that the by-products of alcoholic liquors are present in amounts much too small to exercise any deleterious action in general; and that, in view of this conclusion and of the results of the chemical work, it is as unnecessary as it would be undesirable to fix standards of "purity" or to introduce Excise tests of quality.

Excise technical enquiries.—In compliance with requests made from time to time by the Excise Committee and other officers authorised to apply to me for technical assistance in connection with Excise control generally, the following subjects have also been investigated :—

Obscuration.

The important Excise question of obscuration of alcoholic strength has been considered and suggestions have been offered which if adopted will put an end to certain large recurring losses of revenue which have hitherto been unnoticed or have been allowed to lapse for lack of directive information on the subject.

Hydrometers, etc.

The general accuracy of Excise hydrometers has been examined with the result that a large proportion of instruments are found to give very misleading results thus entailing a serious loss of revenue. The necessity for fixing the responsibility for maintaining the accuracy of Excise instruments on some central expert agency in place of continuing the amateurish and wasteful methods at present generally in vogue has been urged.

Average alcoholic yields.

Attention has again been directed to the absence of definite information on such important Excise matters as the average yield of alcohol from the various fermentative bases used in India. If improved methods of spirit manufacture are to be introduced a thorough investigation of this matter by an Excise Laboratory staff is one of the first requirements. The uncertainty that at present exists has been illustrated by the Dacca Distillery case examined at the instance of the Excise Committee (*vide* Chapter XVI).

Increase of alcoholic strength on keeping.

A great deal of confusion exists at present on certain subjects connected with Excise control, such as the increase of alcoholic strength in spirits on keeping under certain conditions and the necessity for a thorough investigation of this question at an early date by an expert agency is sufficiently obvious.

Blending and shrinkage wastages.

The subject of blending and reduction wastages is another matter of Excise control which at present is in a very unsatisfactory condition. Indeed, it would appear that British Excise methods in general have been blindly adopted in India in ignorance of the profound modifications resulting from tropical conditions and without any effort to modify them for use in India.

Dyeing of duty-paid spirits and opium.

The questions of the ready identification of duty-paid spirit and opium by means of dyes and the associated simple Excise tests are worthy of close attention and of thorough investigation in an Excise Laboratory.

Necessity for critical investigation of Indian Excise technical processes.

In fact, it is only too evident that Excise technical operations in general have been hitherto sadly neglected in India and the consequence has necessarily been the sacrifice of a considerable amount of revenue. A close technical investigation of the whole subject is hence a clear necessity.

Improvement of spirit-manufacture.—As regards the improvement of spirit-manufacture in India the chief requirements have been shown to be :—

Training of distillers and Excise men the first essential.

(1) The technical education at a Central Distillery School of the distiller and, in the public interest, the certification of his fitness for his duties.

(2) The technical training in Distillery methods of manufacture and in Excise control-work of those classes of Excise officers who are, or may be, placed in charge of distilleries.

Expert inspection of distilleries

(3) The provision of a small expert inspecting staff which would be the means of ensuring the practical utilisation of the knowledge acquired by distillers and Distillery Superintendents and one of whom could also assist in conducting the practical course of training at the Distillery School.

Inspectors should be *trained practical distillers* recruited from England.

It is suggested that the existing Madras arrangements should be allowed to continue as regards Excise Laboratory and School; and that two *practical distillers* should be recruited from home and allotted to certain specified groups of Provinces. A great deal of the success of the scheme will turn on the capacity and energy of these two men and their selection should be a matter of special care.

Necessity for expert chemico-technological assistance.

4. Any scheme of distillery improvement which attempted to leave out expert technical control would be certainly doomed to failure. It is found essential by distilling firms to employ a staff of chemists to control their manufacturing operations. To omit this essential is to court heavy loss and to work in the dark. Hitherto in India the Madras Government alone have followed the lead in this respect of practical business men connected with the spirit industry in India and elsewhere, and of all Governments which derive a large revenue from this source. If ever there was a strong case for expert assistance in excise matters it exists at present in India. This report alone furnishes instances enough of the dangers and losses incidental to past attempts to conduct intricate technical excise operations by means of wholly untrained amateurs. All recent special Excise Reports emphasize the same point and there is surely no necessity to dwell further here on what has been recognised as an urgent elementary requirement for many years past.

Subjects urgently calling for investigation at a Central Excise Laboratory.

Among the subjects that should earliest engage the attention of such a Central Excise Laboratory have been cited :—

(1) Spirit yields.

(1) The investigation—chemical and technological—of the spirit-yields from the various fermentative bases under rational conditions of manufacture.

(2) Best yeasts to employ in India.

(2) The ascertainment of the most advantageous forms of yeasts to use in India.

(3) Regular supply of pure yeasts to distilleries.

(3) The regular supply of distilleries with suitable yeasts (for without this all attempts at distillery reform will be futile).

(4) Control of spirit manufacture by analysis.

(4) Systematic analyses of the spirits produced in various Indian distilleries with the view of ascertaining the efficiency of manufacture and wholesomeness of quality, especially as regards freedom from excessive amounts of acid and of furfural. The loss from acid obscuration makes this of additional importance from considerations of Revenue.

(5) Fermentation failures' investigation.

(5) The investigation of fermentation failures,—a technical bacteriological problem, in most cases, as well as chemical and yeast cultural.

(5) Hydrometer standardisation.

(6) Regular systematic control of the accuracy on issue and restandardisation of excise hydrometers, saccharometers, etc., and the devising of inexpensive suitable patterns for India.

(7) Obscuration tables.

(7) The possibility of preparing obscuration tables in order to avoid losses from casking obscuration.

(8) Reduction, etc., wastages.

(8) Wastages from Reduction, Blending, etc. The whole subject wants working out for Indian conditions.

(9) Evaporation losses.

(9) Investigation of evaporation losses of spirit in India, which has been shown to be a subject concerning which there exists little if any definite information at present.

(10) Dyes.

(10) Dyes for spirits and opium.

(11) Wash analyses.

(11) Analyses of fermented or spent washes where fermentation failures have occurred and the indication in each case of the necessary preventive measures to be taken.

(12) Other miscellaneous excise work, and special investigations.

(12) A reference to the list of work done in the Madras Excise Laboratory will furnish further examples of the routine work which would be required of such a Central Excise Laboratory. Besides which special excise investigations would be of very frequent occurrence as occasion for them arose all over India.

Suitable climatic conditions requisite for yeast- and excise chemical work.

5. To attempt to carry on such work in a plain's station would be out of the question and the danger of attempting such has already been illustrated by the Customs' obscuration case cited and by the experience which has accumulated at the Kasauli Laboratory. Any proposal to undertake work of this description, not to mention yeast culture on an industrial scale, under tropical conditions could only emanate from persons practically unacquainted with the nature of such work and of its special difficulties and necessities.

Appointment of a yeast specialist.

6. As regards the supply of suitable yeast to distilleries I would propose that a start be made as soon as possible by causing a suitable man (and I am prepared to submit the name of such if desired) to be trained in the latest methods of yeast-growth in London.

Distillery-school and Excise Laboratory should be close together, combining between them plains' and hills' conditions.

7. The distillery-school and Laboratory should be sufficiently near each other to allow of certain technological investigations being carried on conjointly. The advantages of Kalka and Kasauli in this connection have already been mentioned.

8. *Acknowledgments.*—My cordial thanks are due to Mr. Jenks (Senior Chemical Assistant), and to Captain Nutt, I. M. S. (Physiological Assistant), for their able assistance. Mr. Perkins (Junior Chemical Assistant) has also worked hard and well. The native staff have performed their duties to my complete satisfaction.

KASAULI;
June, 1906.

C. H. BEDFORD.

G. C. Press, Simla.—No. 280 Fin. D.—3-7-06.—450.—N. N. D.

APPENDIX.

DETAILED ACCOUNT

OF

Methods of Manufacture employed in Distilleries in India.

List of questions, drawn up by Major C. H. Bedford, regarding Distillery Processes in use in India, for circulation to Local Governments.

PROVINCE OF—

District—

I.—Name of distillery.

II.—What class of still is used :—*e.g.*, pot-stills ; goose-neck stills, fire-heated ; steam-heated stills ; etc. Describe the stills and state their approximate capacity.

III. (*a*) Enumerate *all* the materials used in the preparation of the liquor.

(*b*) State the proportions in which these materials are used.

IV.—Describe fully the process or processes employed.

V.—How long is the mash left fermenting :—

(*a*) in the hot season ;

(*b*) in the cold season.

VI.—What time is allowed to elapse between the completion of fermentation and distillation ?

VII.—What is the *average* strength (in terms of proof spirit) of the spirit taken from the receivers ?

VIII.—Is the freshly made spirit kept any time before being put on the market ? If so, for how long ? State the rules, if any, governing this matter.

No. 1144, dated Ootacamund, the 11th October 1904.

From—The HON'BLE MR. J. N. ATKINSON, I.C.S., Acting Secretary to the Government of Madras, Revenue Department,

To—The Secretary to the Government of India, Finance and Commerce Department.

I am directed to reply to Mr. Campbell's letter No. 5474-S. R., dated the 30th August last, regarding the deputation of Major C. H. Bedford, I.M.S., for the purpose of conducting an enquiry into the quality of the country spirit sold in India.

2. The distilleries which could profitably be visited by Major Bedford are those at Aska in the Ganjam district, Renigunta in the North Arcot district, and Nellikuppam in the South Arcot district. The first because the system of fermenting wort employed differs entirely from that used elsewhere, the second as a typical pot-still distillery producing spirit from jaggery only, and the third as a typical high-class distillery producing spirit from molasses. If the enquiry is to be extended to the spirit manufactured from toddy, Major Bedford might also visit Chowghat in the Malabar district.

The Aska distillery is situated 25 miles from the Berhampore (Ganjam) station on the Bengal-Nagpur railway. Transit from the station to Aska is by bullock cart. Renigunta distillery is about 1½ miles distant from the Renigunta station on the north-west line of the Madras railway, and the Nellikuppam distillery is close to the station of that name on the South Indian railway. The Chowghat distillery is 33 miles by back-water from the Tirur station on the south-west line of the Madras railway.

3. The note herewith forwarded contains the information called for by the Government of India in paragraph 1 of their letter as regards the distilleries at Aska, Nellikuppam, and Renigunta. As regards similar details for the other distilleries in this Presidency, a further communication will shortly be made.

NOTE.

I.—*Aska distillery.*

II.—Two continuous steam-heated stills are in use. They are constructed of wood chambers with perforated copper bottoms forming a column about 30 feet high. They can distil 6,000 gallons of wash per 12 hours' continuous working, outturning on an average about 534 proof gallons of liquor.

III.—The material used is cane molasses dissolved in water in the proportion of either 1·5 cwt. or 1·1 cwt. per 100 gallons of water. The former solution has a specific gravity of 1,050° and the latter of 1,038°. To assist the inversion of the cane sugar into glucose, sulphuric acid and sulphate of ammonia are employed in quantities determined by the nature of molasses in use. Fermentation is induced by the use of atchoo rice which is prepared by par-boiling rice, sprinkling it when spread in thin layers on a floor with a vegetable preparation known as "sondi mondoo" prepared from various barks and roots, and allowing it to dry. It is then broken up into small cakes which are added, as necessary, to the newly set up wash.

IV.—Wash is prepared in wooden mixers of a capacity of about 2,000 gallons each, each provided with a steam coil. Into one mixer 30 cwts. of molasses are put, into a second 22 cwts. water is added and thorough admixture ensured. Steam is then turned on through the coil and the supply maintained, until the temperature of the wash reaches the boiling point, sulphuric acid being at the same time added to the solution. Steam is then turned off, more water added and mixing still continued until the required initial specific gravity is obtained. From the mixers the wash passes to a wash well whence it is pumped into the wash backs in the fermentation room. Here the "atchoo rice" is added as the wash reaches the wash back. There are 28 wash backs with a total capacity of about 57,000 gallons, and they are all connected by pipes furnished with cocks forming a "diffusion battery." The backs are arranged in two rows of 14 each and "atchoo rice" is added only to the wash in the first back of each series. When fermentation has well started in these backs, from one-half to two-thirds of the fermenting wash is passed into the next empty back and fresh wash added to fill the vessels. This process is repeated until the whole of diffused wash is ripe for distillation. Sulphate of ammonia is added at the discretion of the distiller during the course of fermentation to act as yeast food, and finally before the wash is sent to the still lime is added to it to remove by precipitation, as calcium sulphate, the sulphuric acid previously added which if left unneutralized would quickly destroy the copper diaphragm plates of the still.

V.—No wash is set up during the months of May, June and July owing to the high temperatures. During August and September fermentation takes about three days: during the remainder of the manufacturing season about four days.

VI.—Ordinarily wash is sent for distillation directly fermentation ceases.

VII.—The average strength of the liquor taken from the receivers is 32·5° O. P.

VIII.—The freshly-made spirit is made available for issue as required; no attempt is made to mature the liquor, the demand for the Ganjam district being equal to the capacity of the distillery. At the utmost liquor is only retained a few days in the distillery warehouse before being issued either at its original strength to a bonded warehouse at Tekkali, or after reduction to wholesale vend depôts or shops. There are no rules in force in this Presidency regulating the retention of liquor in distilleries.

I.—*Renigunta distillery.*

II.—There are three ordinary goose-neck stills of a capacity respectively of 850, 1,250 and 1,350 gallons, heated by fire.

III.—The materials used are jaggery and vellum (*acacia alba*) bark. From 200 to 250 lbs. of jaggery are dissolved in each 100 gallons of water, and from 12 to 20 lbs. of bark are added.

IV.—The required quantity of bark is placed in an empty wash back and from 15 to 25 gallons of fermenting wash added. On the next day the back is filled to about one-third its capacity with water, the required quantity of jaggery added and the mixture stirred until all the jaggery is dissolved. Water is then added until the required quantity and specific gravity of the wash are obtained, the solution being again well mixed. The wash is vigorously stirred up twice daily for about three days until fermentation is strongly set up.

V.—The period required for fermentation is from five to seven days in the hot and from eight to ten days in the cold season.

VI.—Ordinary wash is passed to the stills for distillation immediately it is ready. Occasionally it may be found necessary to retain it for a day after this stage is reached owing to no still being then available.

VII.—The strength of the spirits taken from the receivers varies from 12·0° U. P. to 80° U. P. when wash is distilled and from 25·0° O. P. to 60° U. P. when weak liquor is redistilled. Each still is provided with duplicate receivers, one for strong and one for weak liquor, the whole of the latter being afterwards redistilled.

VIII.—Liquor is sent from the distillery, as required, to the distiller's bonded warehouse at Madras. The period during which it may be retained in the distillery depends entirely upon the demand from the warehouse, but at the greatest it will never exceed a few days. No attempt is made to mature the liquor before issue.

I.—*Nellikuppam distillery.*

II.—One Coffey's still, three continuous stills, and two rectificators, all steam-heated, are employed. The Coffey's still consists of two columns, the analyser and the rectifier, each of which is composed of a number of chambers superimposed upon each other and separated by perforated copper plates. The wash is pumped through a pipe which enters the second compartment from the top of the rectifier and passes horizontally through each lower compartment twice; from the bottom chamber it is carried direct to the top of the analyser where it discharges into the top chamber. Here the wash is brought into contact with steam which is forced upwards through the perforations in the copper diaphragms. As it passes down from chamber to chamber it loses its alcohol which is carried up with the steam, until on reaching the lower chamber it is perfectly free from spirit. The ascending mixed steam and spirit vapour passes by a large swan-neck pipe from the top of the analyser into the lowest compartment of the rectifier where it is brought into contact with the pipe conveying the wash. As it ascends through the perforated diaphragms water vapour and feints—the higher alcohols and acids are separated and flow out of the column into a feints receiver separator whence it is again pumped to the top of the analyser and thus continuously redistilled. The ethereal vapours are conducted through a pipe at the top of the rectifier to a small condenser on the top, and after condensation are again returned for redistillation by a pipe entering the 16th chamber of the rectifier. The steam pressure is so regulated that the temperature of the top chamber of the rectifier shall be that of the boiling point of strong alcohol, and the spirit vapour on reaching this chamber comes into contact with the cold wash pipe and is condensed, falling upon a plate called the "spirit plate" whence it is conducted to a refrigerator where it is finally cooled and passed to the receivers.

The other three stills, though differing somewhat in size and details, are of the same description. They consist of a copper column divided into chambers separated by perforated copper diaphragms. The steam enters at the bottom of the still, and in rising through the column meets the descending wash which is supplied to the stills from wash chargers placed overhead to which it is pumped as required. On emerging from the top of the column the mixed steam and alcohol vapour passes first through a vessel called the "forewarmer" through which the wash passes on its way to the column and afterwards to a condenser where it loses much of its water and higher alcohols, which are collected and returned to the column for redistillation. The condensed spirit is then conveyed to the receivers.

The rectificators differ only in detail from the continuous stills already described, but in them liquor is redistilled instead of wash. The liquor to be redistilled is placed in the boiler of the rectificator, reduced to a strength of about 30° U.P. and sufficient lime added to fix all the acids present. Steam is then passed through a coil placed in the boiler and the liquor boiled. The vapour in ascending the column loses much of its water and passes from the top of the column into a condenser, thence through a feints separator where the remainder of the water vapour and the feints are separated and returned to the column for redistillation, and finally into a second condenser where it is cooled and sent to the receivers. The stills are respectively capable of outturning the following quantities of proof gallons of liquor per diem :—

	Proof gallons.
No. I, Coffey's still	1,800
„ II, Continuous „	280
„ III „ „	1,000
„ V „ „	280

Rectificator No. IV rectifies 500 gallons of proof spirit in 12 hour.

Rectificator No. VI rectifies 600 gallons of proof spirit in 1 hour.

III. The materials used for the preparation of wash are molasses or jaggery, sulphuric acid, sulphate of ammonia, and vellum bark. Each wash back has a working capacity of 3,500 gallons, and to fill it the following materials are used :—

50 cwts. molasses or jaggery.

½ gallon sulphuric acid.

12 lbs. sulphate of ammonia.

250 lbs. vellum bark.

IV.—The vellum bark is first soaked for about 10 hours in about 60 gallons of molasses solution. The required quantity of molasses or jaggery is put into a mixing tank, water being added until the density of the solution is 1,050 or 1,051. Mixing is performed by men walking about for an hour or more in the solution. The sulphuric acid is added at this stage and the wash when ready is pumped direct to the wash back in which the bark has already been soaking. Then the sulphate of ammonia is added and the whole wash thoroughly mixed up. In 28 to 32 hours the wash is ripe for distillation, and is at once passed into the wash chargers and thence to the stills.

V.—In the hot weather the average duration of fermentation is as above stated ; in the cooler weather it takes about 4 hours longer.

VI.—As stated *supra,* wash is sent for distillation directly fermentation ceases.

VII.—The average strength of liquor outturned by each still is as follows :—

Still No. I	50° O. P.
„ „ II	45° O. P.
„ „ III	50° O. P.
„ „ V	Proof.
Ractificator No. IV	65° O. P.
„ „ VI	66° O. P.

VIII.—Spirit is issued from the distillery according to the demand from outside, no system of retaining any portion of it specially for purposes of maturing being recognised. The bulk of the liquor is issued to the distiller's bonded warehouses at a strength of about 40° O. P.

I.—Vizagapatam Distillery (Vizagapatam District).

II.—Two continuous steam-heated stills are in use. Each consists of a retort containing a steam coil, an analysing column, a forewarmer and a condenser with coils. Each still can distil about 250 gallons of wash per hour outturning 40 gallons of proof spirit.

III. and IV.—Wash is prepared as follows :—

In each cask 100 lbs. of cane jaggery are dissolved in 40 gallons of water ½ lb. of sulphuric acid and ¾ lb. of ammonia sulphate are added to the solution to aid fermentation and the contents of each cask are made up to 50 gallons, the whole being well stirred.

V.—Six to eight days during the hot and seven to nine days during the cold season are required for complete fermentation.

VI.—As soon as fermentation ceases the wash is sent for distillation.

VII.—The average strength of liquor taken from Receivers is 14·2° O.P.

VIII.—Spirit is issued from the distillery according to the demand. No attempt is made to mature it before issue.

I.—Samalkot Distillery (Godavari District).

II.—Two continuous steam-heated stills are in use. The working of these two stills is identical in details. Each still consists of a copper column divided into seven chambers having in each diaphragm with cups. The steam enters the boiler portion of the still and as it ascends the column meets the wash descending from the two wash heaters. The wash is supplied to the heaters from wash charges placed over-head to which the wash has to be pumped. The spirit vapour passes out of the column through a pipe which first passes through the wash heaters and then through the condenser whence after condensation the spirit passes to the receiver. Each still can distil 400 to 500 gallons of wash per hour outturning from 31 to 38 proof gallons of spirit.

III.—The materials used for the preparation of wash are palmyra treacle, cane treacle, palmyrah and cane runnings and the washings of gunnies which have held jaggery. These are dissolved in water in the proportion of 50 % of runnings to 25 % of cane and 25 % of palmyra treacle. Ten candies of 500 lbs. each of the materials in the above proportions are required for 3,000 gallons of wash. The solution has a specific gravity of 1,050°. To each set up of 3,000 gallons the fermenting agents, yeast, sulphuric acid, sulphate of ammonia and acacia alba bark are added in the following proportions :—

4	lbs. of yeast,
75	lbs. of acacia alba bark,
5	lbs. of sulphate of ammonia, and
40	ounces of sulphuric acid.

IV.—Wash is prepared in two masonry tanks of 7,000 gallon capacity each. Water is passed into these tanks, the treacle and runnings in the aforesaid proportion added and the solution thoroughly mixed until it reaches a density of 1,050°. The wash is then pumped into the wash backs and the fermenting agents added.

V.—Fermentation is complete in from 36 to 40 hours during the hot and from 40 to 48 hours during the cold season. If, however, cane treacle alone is used, complete fermentation takes a longer time lasting from 56 to 70 hours in the hot and 64 to 80 hours in the cold season.

VI.—Ordinarily the wash is sent for distillation immediately fermentation ceases.

VII.—The average strength of spirit taken from receivers is 50° O. P.

VIII.—The spirit is not stored for any period before issue with a view to maturing it. The issue is entirely controlled by supply and demand.

I.—Tadpatri Distillery (Anantapur District).

II.—Two fire-heated copper pot-stills of capacities varying from 900 to 1,000 gallons are in use. Goose-necks are connected with coils passing through condensers. They can distil about 55 to 60 gallons of wash outturning from 7 to 8 proof gallons of spirit per hour.

III.—The materials used for fermentation are cane jaggery, 'acacia alba' bark and spent wash. Generally, to make 100 gallons of wash, to 43·8 gallons of water are added an equal quantity of spent wash, about 205 lbs. of cane jaggery and 32·8 seers (1 seer=21 tolas) of acacia alba bark. Eight drams of previously set up fermenting wash is added at a later stage to aid fermentation.

IV.—The wash is set up in casks of about 36 gallon capacity. The contents are stirred twice daily from 15 to 20 times. The total set up at a time amounts to 650 gallons. Weak liquor requiring redistillation is sometimes added to wash before distillation commences.

V.—Fermentation is complete in from 10 to 14 days during the hot and from 12 to 16 days in the cold season.

VI.—Ordinarily, wash is sent to still immediately fermentation ceases.

VII.—The average strength of liquor in receivers is 18° U. P.

VIII.—No attempt is made to store liquor for any period before issue with a view to maturing it. It is issued as the demand arises.

I.—Bellary Distillery (Bellary Distirct).

II.—Three fire-heated country made copper pot-stills of 700 gallons capacity each are in use. Each can distil about 60 gallons of wash per hour producing about 8 proof gallons of liquor.

III.—Jaggery, spent wash and acacia bark are the materials used in the preparation of wash. For a set up of 700 gallons of wash 300 gallons each of water and spent wash, 60 maunds of jaggery (1 maund=25 lbs). and 8¾ maunds of bark are used.

IV.—Wash is prepared in casks of 35 gallons capacity each. The proportionate share of jaggery is dissolved in water and the spent wash and acacia bark are then added. The wash is allowed to ferment until the density of the solution falls from about 1,077° to 1,000°.

V.—In the hot season the wash is left fermenting from 6 to 8 days and in the cold season from 13 to 14 days.

VI.—The stills are charged with wash directly the fermentation ceases.

VII.—The average strength of liquor taken from receivers is 20° U. P.

VIII.—The spirit is not kept for any time before being put on the market. As the demand arises it is issued.

I.—Tachanallur Distillery (Tinnevelly District).

II.—Three fire-heated country made copper pot-stills of 850 gallons capacity each are in use.

III.—The materials used are palmyra jaggery and vellum bark (acacia alba).

For a set up of 800 gallons of wash 18 $\frac{56}{112}$ cwts. of palmyra jaggery and $\frac{94}{112}$ cwt. of bark are used.

IV.—Each set up of 800 gallons of wash requires 94 chatties, 7½ gallons of water, 22 lbs. of palmyra jaggery and 1½ lbs. of vellum bark are placed in each chatty. The initial gravity cannot be ascertained on the first day owing to the non-solution of the jaggery. On the 2nd day the contents of each pot are stirred thoroughly both in the morning and evening. The gravity of the wash is tested from the 2nd day until it is sent to still.

V.—Six days in the hot and about eight days in the cold season are required for complete fermentation.

VI.—Soon after fermentation ceases wash is sent to still.

VII.—There are duplicate receivers for each still to separate the strong from weak liquor. The strength of the strong liquor ranges from 15° to 30° U. P. while that of the weak liquor ranges from 60° to 80° U. P.

VIII.—According to the demand from outside, spirit is issued from the distillery, no system or storing it for maturing being recognised.

I.—New Eden Distillery (Madras District) (Veyasarpady).

II.—Two stills on a fire-heated country made copper pot-still of about 800 gallons capacity, the other a steam-heated, country-made, copper, continuous still, are in use. The working capacity of the latter is 200 gallons of wash per hour. The working details of both stills are of the usual type.

III.—The materials used for preparation of wash are jaggery, sulphuric acid, sulphate of ammonia and vellum (acacia alba) bark, the latter only occasionally. For a set up of 700 gallons of wash 1,250 lbs. of jaggery, 3 to 6 lbs. sulphate of ammonia, 3 to 4 ozs. of sulphuric acid and about 20 lbs. of vellum bark are used.

IV.—The jaggery is dissolved is a wash back of 700 gallon capacity, the solution having a density of about 1,050°. At this stage, sulphuric acid, ammonia sulphate and vellum bark in the aforesaid proportions are added and fermentation proceeds and until the density of the liquid falls to about 1,000° when it is ready for distillation.

V.—Fermentation is complete from 4 to 6 days in the hot and 6 to 9 days in the cold season.

VI.—Generally, wash is sent for distillation soon after fermentation ceases.

VII.—The average strength of spirit taken from the receiver attached to the pot-still is 49·5° U. P. while the strength of that taken from the receiver attached to continuous still is 7·9° U. P.

VIII.—Without any limit as to the duration of storing spirit is issued as demand arises.

I.—Chavalkat Distillery (Malabar District).

II.—Two ordinary fire-heated, country-made, copper pot-stills of 750 gallons capacity each are in use. Each still can distil about 84 gallons of toddy per hour.

III.—Fermented cocoanut toddy is the only material used. Cocoanut toddy arrack only being manufactured at this distillery.

IV.—Fermented cocoanut toddy obtained from trees tapped in the neighbourhood is brought to the distillery in casks or chatties. It is distilled on the day after receipt or whenever a full still charge is collected.

V.—Until a still charge is collected which generally takes 24 hours, fermented toddy is kept stored in casks. This is the case both in the hot and cold season. The outturn in the hot season is a little less than that in the cold season.

VI.—Toddy is distilled as soon as fermentation is complete.

VII.—The average strength of the liquor first outturned is 73° U. P. This is redistilled and liquor of about 15° U. P. obtained. By further redistillation spirits of 13° and 20° U. P. are obtained.

VIII.—The demand for the liquor controls the issue of spirit. As the demand arises, spirit is issued without any regard to its age.

I.—*Coimbatore Distillery (Coimbatore District).*

II.—There are in use three fire-heated, country-made pot-stills of 1,150, 1,150 and 850 gallons capacity respectively. To each still are attached two rectifiers of about 100 gallons capacity in which wash is placed and through which all the spirit vapour from the still passes before being condensed.

III.—The materials used for the preparation of wash are palmyra jaggery, spent wash and vellum bark (acacia alba). For a set up to 156 gallons of wash 325 lbs. of palmyrah jaggery, 20 gallons of spent wash, 25 lbs. of white vellum (acacia alba) bark and sufficient water are used.

IV.—Palmyra jaggery in the aforesaid proportion is put into a wash back. Sufficient water is then added to ensure thorough solution. Spent wash and white vellum bark are then added and the whole thoroughly stirred. The wash ferments until the gravity falls from 1,070° to 1,025° when fermentation stops.

V.—Eight days in the hot and nine to ten days in the cold season are required before the fermentation ceases.

VI.—As soon as fermentation ceases the wash is sent to still.

VII.—The average strength of liquor obtained in the strong spirit receiver is 15° U.P., while in the weak liquor receiver it is 70° U.P.

VIII.—There is no opportunity for the spirit to mature. The outturn is only equal to the demand and as this demand arises the spirit is issued.

BOMBAY

AND

SIND.

No. 7462, dated Bombay Castle, the 30th September 1904.

From—The HONOURABLE MR. R. A. LAMB, C.I.E., I.C.S., Acting Chief Secretary to the Government of Bombay,

To—The Secretary to the Government of India, Finance and Commerce Department.

I am directed to acknowledge the receipt of the letter from the Government of India, No. 5474-S.R., dated 30th August 1904, asking for certain particulars in respect of the distilleries in the Bombay Presidency which should be visited by Major C. H. Bedford, I.M.S.

2. In reply, I am to state that almost the whole of the country spirit manufactured in the Presidency proper is distilled either from mhowra flowers or from toddy In the mhowra distilleries distillation is for the most part carried on after European methods, though there are differences in the forms of the stills and the appliances used ; while in the distillation of toddy spirit, which is carried on on a smaller scale, simpler methods are adopted. I am to suggest that Major Bedford should be directed to visit the following typical distilleries of both classes :—

(1) The group of private distilleries at Mora, where the distillers carry on their business according to their own varying methods, subject only to such control as will ensure the wholesomeness of the liquor and the due collection of the revenue. These can be reached by an hour's journey by launch from Bombay.

(2) The Government Central distillery at Dhulia on the Chalisgaon-Dhulia branch of the Great Indian Peninsula Railway.

(3) The toddy distilleries at Dadar in Bombay Island.

3. The Commissioner of Customs, Salt, Opium and Àbkari, reports that all the particulars called for in the memorandum appended to the letter from the Government of India under reply cannot be furnished without reference to the different distilleries and that the return may not be complete before Major Bedford's arrival in October. As, however, Major Bedford may find it convenient to begin inquiries in this Presidency, the Governor in Council has indicated at once the distilleries which should be visited. I am to add that the detailed information will be furnished to the Government of India as soon as possible on its receipt from the Commissioner.

4. As regards the Province of Sind, I am to forward copy of a statement and of the list accompanying it, submitted by the Commissioner in Sind, containing information on the various points specified in the memorandum. It will be seen that the English equivalents and botanical terms for the ingredients mentioned in the list have been supplied as far as possible. The Government distillery at Kotri is the only distillery in the province of Sind. It is situated about three miles from the Railway Station where carriages are always available.

ABKARI.

Information asked for by the Government of India regarding the distilleries in the Bombay Presidency.

PROVINCE OF SIND.

District Karachi (the distillery is, however, under the control of the Collector of Hyderabad).

I.—Name of distillery ... Kotri Government Central Distillery.

II—Classes of still used ... 1. Worm stills. 2. Pot stills.

There are eight licensed distillers working 13 worm stills and eight pot-stills, or one pot-still each. These pot-stills are only used for the manufacture of special liquor in small quantities (generally eight gallons at a time) ordered to be manufactured according to their own receipts by private individuals in possession of special permits or special orders granted them, under the Bombay Abkari Act, No. V of 1878, to possess specified quantities of country spirit in excess of one gallon.

Pot-stills are small copper pots of the average capacity of 59 or 60 gallons the mouth of which is capped by a copper condensor with a plate concave below and convex above and surrounded by a copper plate. The upper portion of this condensor is constantly filled with cold water while the still is being worked, which has the effect of liquefying the steam rising from the pot and causing it to flow out through a tube at the side of the condensor into a receiver.

Worm stills are large copper cauldrons or boilers of the average capacity of 188 gallons. The boiler is embedded in masonry above a furnace and it is topped by a wooden cap having a copper syphon or tube fixed to the top of it and connected by means of a detachable copper pipe with a series of spiral copper tubes, called a worm, bolted together, adjacent to the boiler and placed in a large wooden vat of cold water through the lower portion of which the thin end of the copper tubes projects and discharges liquor into a receiver. On this still being charged and worked the steam rises into the wooden cap and is conducted by the copper syphon into the spiral worm contained in the vat of cold water where it is condensed and discharged into a receiver in the shape of liquor.

III.—(*a*) All materials used in the preparation of liquor are enumerated in the attached list.

(*b*) Coriander is used in the proportion of 1 lb. to every chatty or 8 lbs. of liquor. Sandalwood ¼ lb., when manufacturing liquor flavoured with rose leaves or other flowers. When rose flavoured liquor is manufactured 3 lbs. rose leaves are used for every eight gallons of liquor.

When orange and aniseed flavoured liquor are manufactured 2 lbs. orange peel or aniseed are used respectively.

For musk flavoured liquor ½ masa musk is used for 8 gallons.

All the other ingredients are used in the proportion of ½ lb. to every eight gallons of liquor.

IV.—Liquor is manufactured in this distillery from molasses.

The process is as follows :—

A certain quantity is soaked in casks of water along with a proportion of babul bark to accelerate fermentation. After soaking three days extra water is added and the mash is turned over twice daily. The refuse thus brought to the surface is removed. The process continues till the mash is ripe for distillation. It is then conveyed to the stills and distilled. The single distillation turned out is then immediately distilled a second time along with the flavouring ingredients necessary to manufacture a particular kind of flavoured liquor. This second distillation completed the process of manufacture, and is conveyed to the liquor store rooms whence it is tested, measured, brought on the Government stock books and issued on permits.

V.—The mash is left to ferment—

(*a*) in the hot season from 8 to 10 days,

(*b*) in the cold season from 10 to 15 days.

VI.—No time is allowed to elapse between the completion of fermentation and distillation. Directly fermented matter is fit for distillation, it is put into the stills and double distilled.

VII.—The average strength of spirit taken from the receivers is about 6° U.P. The alcoholic strength is, however, manipulated by the addition of smaller or larger quantities of the after drawing, called distilled water, in order to have the strength of the outturn between the strengths fixed for superior and inferior spirit. The present limits of superior spirits are between 4° and 8° U. P. " and those of inferior spirit between 35° and 40° U. P."

VIII.—Freshly made spirit is stored for at least one day in the liquor store rooms before it is permitted to be issued for consumption.

The Commissioner's rule bearing on the subject runs thus:

" No spirit shall be removed from the distillery before it has been double distilled and stored in a compartment of a strong room appointed for the storage of double distilled spirit.

B. A. BRENDON,
Acting Collector of Hyderabad.

LIST OF INGREDIENTS USED IN THE PREPARATION OF HIGHLY SPICED LIQUOR.

Names of ingredients.

Almond.

Agar—(wood of aloes).

Aniseed.

Asgund—root of the Physalis flexnosa.

Alisundh—green ginger.

Aukerkerho—pellitony.

Asaroon.

Apples.

Awra.

Ahuber—fruit of Juniperus communis.

Aftimoon.

Badrung seed—a sort of cucumber.

Babunue—Anthemis nobilis chamonile.

Bahman red } Benalbum ribrum
Bahman white } (Centansea behen, L.)

Bahera—Terminalia belerica, L.

Bulbij—A medicinal seed.

Behidana—Quince seed.

Babul bark—Acacia arabica.

Betel nuts.

Benifcio—Leaves and flowers of the violet used in making syrup.

Bisfaij—Species of Polipodium and Adiantun.

Boor dayal—Blossom of most Arce (Unaria longrifolia.)

Bazidana.

Camalpat—Leaf of the Cassia tamala.

Cardamom, large.

Cardamom, small.

Carrot seed.

Chabar—Cynodon dactylon.

Chitrak—Plumbags rosea.

China root.

Cinnamon.

Chachro Tilri—Fumaria pamiflora.

Cloves.

Cocoanuts.

Coriander.

Cotton seeds.

Counch bij.

Cababchini—Piper cubeba.

Cumuih seed.

Cumuih seed, white.

Daifal.

Damaho—Fagonia mysorensis.

Darunaj—Doronicum scorpoides.

Dates.

Figs.

Faudak.

Gazban—Helistropes.

Ginger.

Gokhro—Tribulus lanuginosus.

Gul Benifcio.

Gul Gazban—Flower of Heliotrope.

Gul Chobi.

Gul Khairo—A kind of hollyhock.

Gum.

Ghee.

Harir—A kind of Myrobalans.

Hurmuro—Ruta hurmala.

Ilsi—Linseed (Linum usitatissimum.)

Inderjaw—Nerum antidysentericum.

Injni—Unripe chebulic Myrobalan.

Ispanger—Planbago ispoghul.

Jaffer.

Jan—Ajwan seed (Ptychotus ajowan).
Kahera—Species of Rhus.
Kailperu—Solanum incertum.
Kamacho.
Kapur kacheri—Zedwari.
Karno flower.
Kashini—Cicharaum intybus.
Katilo—Gum tragacanth.
Khakshher.
Khas Khas.
Kullh.
Kinro—Gynandropsis pentaphylla.
Kuth.
Kamarkas—A gum resembling Kino got from the Butea frondosa.
Lessura—Fruit of Crodia latifolia.
Liquorice root.
Lunak seed—Portulacca Obracea.
Mihlab—Sweet smelling seeds of a plant.
Mangoes.
Melon seed.
Mochrous—Gum of the Moringa petereosperma or horse-radish tree.
Molasses.
Moondherry—Carchorus depressus.
Mekhwal.
Miti kath—Catechu.
Moosly, black—product of Curculigo brenifolia.
Moosly, white—rootless (*sic*) of, Salmalia malabanica.
Manjith—Rubia cardifolia (Indian Madder).
Motio flower—Jasminum zambac.
Milk.
Musk.
Nastaki Rumi—Mastich (the resin of Pistachia Centiseus.)
Mur—Lahiatoe.
Nagermoth.
Neza—Pinus neoga or Pinus geradiann.
Nilopher—Nelumpium speciosum.
Nimboor, dry
Nimboor, fresh } Blossom of Melia azederach.
Nutmeg and mace.
Onion seed.
Ood.
Orange.
Panel—the leaves and stalks of the Pogostemon patchouli.
Paper—Family Solanaceæ (dried berries).
Panpar—Alpinia galango or Galango major.
Pario—Species of lichen used for scenting purposes.
Pursia.
Pepper.
Pepperment, dry.
Pepperment, fresh.
Pistachio nuts.
Pipri—Piper longum.
Poppy head.
Poppy seed.
Rakut chandan—Red sandalwood.
Raddish seed.
Raisin.
Ratnar.
Raisin, black.
Rose, dry.
Rose, fresh.
Sandal wood.
Salib, 1st sort
Salib, 2nd sort } Orchio mascula.
Samuneder Sukh.
Sana—Senna.
Satawal.
Sather—Origanoid.
Sahtro.
Shakar—an inferior kind of soft sugar.
Shah Balut.
Shika gul.
Silk (raw).
Suwa bij—Ancthum sowa seed.
Suhanjhro—Hyperanthera moringa.
Suruijan.
Talibkhana.
Tapasheer.
Tea.
Tujbal.
Tuj lakri.
Till.
Tiffula—The three myrobalans.
Todri.
Tooh—Coloqiunteda or bitter apple.
Tukhum Bala—Seed of Dracocephalum royleanum.
Tukhum Rihan—Seed of Ocymum pilosum.
Tukhum halio.

Tukhum kadu—Seed of Pimpkinor pumpeon (Cucurbita logenaria)

Tukhum kam.

Tukhum khatimi—Althea rosea.

Tukhum khabazi.

Tukhum kulhati.

Tukhum sambola.

Tuj—Sanrus cassia.

Unab—Zizyphus.

Usto khudas—Species of premella.

Uttangan—Seed of Acanthodium hirtum

Utl kachura.

Sal ammoniac.

Azkhar—Andropogon inaraneusa.

Valjan—Umbelliferous seed (Coriander).

Walnuts.

Water-melon seed.

Wavering—Embelia basaul.

Zarawand.

Zoofan—Hyssop.

Ak—Calotropis procera.

Honey.

No. 98, dated Camp Bankapur, the 9th January 1905.

From—The HON'BLE MR. J. L. JENKINS, M.A., I.C.S., Commissioner of Customs, Salt, Opium and Abkari,

To—MAJOR C. H. BEDFORD, I.M.S., on Special Duty, c/o Messrs. King, King & Co., Bombay.

With reference to the correspondence ending with letter No. 6873-Ex., dated the 29th October 1904, from the Government of India to the address of the Government of Bombay on the subject of your deputation to enquiry into the quality of country spirit sold in India, I have the honour to forward herewith the information regarding the points mentioned in the memorandum attached to the letter from the Government of India, No. 5474-S. R., dated the 30th August 1904, in respect of each distillery in the Bombay Presidency.

2. I may mention that country spirit, before being passed from any distillery in this Presidency, is subjected to a test (called the Ferrocyanide test) for the presence of copper. One part of ferrocyanide of potassium is dissolved in nine parts of water, and a few drops of this solution are dropped into samples of spirit brought to the examination shed to be passed. If the sample of liquor examined in this way changes to anything like a claret colour it is rejected as contaminated with copper, and the distiller must then redistil the liquor in clean vessels to get rid of the contamination.

INFORMATION ASKED FOR BY THE GOVERNMENT OF INDIA REGARDING THE DISTILLERIES IN THE BOMBAY PRESIDENCY.

Presidency of Bombay, District Ahmedabad.

I.—Name of distillery.	Ahmedabad Government Central Distillery.
II.—What class of still is used, *e.g.*, pot-stills, goose-neck stills, fire-heated, steam-heated stills, etc. Describe the stills, and state their approximate capacity.	1. Wooden copper steam-still, capacity about gallons 3,000 and holding 90 Indian maunds of mhowra for distillation. This still is for single distillation. 2. English copper steam-still with worm, capacity gallons 180. 3. Fire-heated copper pot worm still, capacity gallons 400. 4. Fire-heated small copper pot-still without worm for superior quality of "masala" (spiced) liquor, capacity gallons 100.

III.—(*a*) Enumerate all the materials used in the preparation of the liquor.	1. Mhowra, generally used. 2. Jaggery } Seldom used. 3. Raisins } Seldom used.
(*b*) State the proportions in which these materials are used.	4. Aniseed. 5. Cardamom. 6. Coriander. 7. Falsha red berries. 8. Ginger. 9. Liquorice root. 10. Milk. 11. Orange peel. 12. Rose flowers. 13. Rose water. } Materials used for "massala" (spiced). No fixed proportion. The manner in which spiced liquor is manufactured is described in the return of the distillery at Godhra in the Panch-Mahals.
IV.—Describe fully the process or processes employed.	Mhowra, jaggery and raisins are in the beginning separately soaked in water for fermentation, after distillation, the yeast is separated from the dregs and after about 20 hours it is mixed with fresh water and after allowing it to stand for from 12 to 15 hours the mhowra, jaggery or raisins are soaked in it.
V.—How long is the mash left fermenting:—	
(*a*) in the hot season;	From 5 to 6 days.
(*b*) in the cold season.	From 7 to 10 days.
VI.—What time is allowed to elapse between the completion of fermentation and distillation?	No time.
VII.—What is the average strength (in terms of proof spirit) of the spirit taken from the receivers?	The strength of single distilled spirit varies from 48° U.P. to 60° U.P. The strength of double distilled spirit, which alone is issued for consumption in the district, is fixed and is 25° U. P. and 60° U. P.
VIII.—Is the freshly made spirit kept any time before being put on the market? If so, for how long? State the rules, if any, governing this matter.	The double distilled liquor is stored in the strong rooms and allowed to stay from one month to two years before being sent to the shops. There are no rules governing this matter.

Presidency of Bombay, District Panch Mahals.

I.—Name of distillery.	Godhra Government Central Distillery.
II.—What class of still is used, *e.g.*, pot stills, goose-neck stills, fire-heated, steam-heated stills, *etc.* Describe the stills, and state their approximate capacity.	The class of still used is of two kinds, fired-heated and steam-heated with goose-neck bends at the top in both cases. The former consists of a copper vessel with a grate underneath it, the heating

	agency being wood fire. The still is connected by a goose-neck bend with a spiral copper coil in a condenser which consists of a wooden vessel, in which cold water surrounds the coil, thus cooling the steam in it, which comes out in the form of liquor. In the case of the latter, *i.e.*, steam-heated stills, the still consists of a big wooden vessel with a copper coil inside all over its bottom in the form of a coiled boa constrictor, steam is passed into this coil, which heats the mhowra thrown on top of it, and the steam from the heated mhowra goes through the goose-neck bend into the adjoining condenser and is condensed in the same way as described above in the case of the fire-heated stills. The fire-heated still has a capacity of distilling about 20 maunds of mhowra and double-distilling 300 gallons of single distilled spirit to 200 gallons of 25° U. P. liquor, and the steam-heated still has the capacity of distilling about 200 maunds (8,000 lbs.) of mhowra and double distilling about 900 gallons of singled stilled spirit into about 600 gallons of 25° U. P. spirit in a day. There are two fire-heated and three steam-heated stills in the distillery here.
III.—(*a*) Enumerate all the materials used in the preparation of the liquor.	(*a*) Mhowra flowers are the only materials used in the actual preparation of the liquor, and
(*b*) State the proportions in which these materials are used.	(*b*) the proportion in which they are used is the following :—3 to 5 gallons of "gurro" (yeast) and 9 to 10 gallons of water to every one maund of mhowra flowers. (For flavouring what is called "spiced" liquor, however, some other materials are also used, but liquor is not actually prepared from them as in the case of mhowra flowers. The materials are only soaked in the already prepared single distilled mhowra liquor and after being allowed to ferment there for about 12 to 15 days, the whole lot is double-distilled to 25° U. P. "masala" liquor. The ingredients thus used are the following :—Rose flowers, orange peels, coriander seeds, carraway seeds, cardamom, liquorice roots, molasses, anise seeds, tamalpatar, bodian and kosin).
IV.—Describe fully the process or processes employed.	Mhowra flowers are first soaked in water and "gurro" (yeast). The stuff is turned twice in the morning and evening and left to ferment, till it is ripe for distillation. The whole stuff is then put into the still and is heated and converted

	into steam and subsequently spirit, as fully stated in the description of the still given above under heading No. II. The spirit at first coming out is very strong, over-proof in fact, but it becomes weaker as the quantity increases, and is drawn till the required strength of 50° U.P. or so is obtained in the case of the single distilled spirit. In the case of the double distilled spirit, the process is the same, only that in this case, the ready made mhowra liquor is put into the still and double-distilled to 25° U.P. or 60° U.P. liquor, as the case may be, which are the two kinds of strength allowed for liquor consumed in this district.
V.—How long is the mash left fermenting:—	
(*a*) in the hot season;	6 to 8 days in the hot season.
(*b*) in the cold season.	8 to 10 days in the cold season.
VI.—What time is allowed to elapse between the completion of fermentation and distillation?	No time.
VII.—What is the average strength (in terms of proof spirit) of the spirit taken from the receivers?	The average strength of the single distilled spirit is 50° U.P. here, but it is not fixed and may vary in other distilleries. That of the double-distilled spirit is fixed and is 25° U.P. and 60° U.P.
VIII.—Is the freshly made spirit kept any time before being put on the market? If so, for how long? State the rules, if any, governing this matter.	Generally the freshly made spirit is kept 10 to 15 days before being put on the market, but this depends much upon the demand, and sometimes it happens that it is kept for a longer time even. There are no rules governing this matter.

Presidency of Bombay, District Surat.

I.—Name of distillery.	The Surat Government Central Distillery.
II.—What class of still is used, *e.g.*, pot-stills, goose-neck stills, fire-heated, steam-heated stills, etc. Describe the stills, and state their approximate capacity.	Goose-neck stills, which are steam-heated. The steam from the boiler passes through a copper coil of pipe which is placed at the bottom of a wooden vat containing the mash. On the top of the vat is the goose-necked tube leading to another wooden vat where the condensing takes place. The actual capacity of each still is 9,500 gallons, but as a rule not more than 1,700 gallons of 60° U.P. spirit is produced from each, while 5,000 gallons can be redistilled.

III.—(*a*) Enumerate all the materials used in the preparation of the liquor.	Mhowra flowers only are used. Spices are also mixed with mhowra liquor in making "masala" liquor.
(*b*) State the proportions in which these materials are used.	375 lbs. of mhowra flowers to 155 gallons of water mixed with yeast.
IV.—Describe fully the process or processes employed.	The mixture of mhowra flowers and water is stirred twice daily for as many days as fermentation last and then put into the still and distilled.
V.—How long is the mash left fermenting:—	
(*a*) in the hot season;	6 to 7 days.
(*b*) in the cold season.	8 to 9 days.
VI.—What time is allowed to elapse between the completion of fermentation and distillation?	No interval.
VII.—What is the average strength (in terms of proof spirit) of the spirit taken from the receivers?	Liquor of 60° U.P. is taken from the stills: some of it is afterwards redistilled to the strength of 25° U.P. A very small quantity is also issued at 15° U.P. for making superior spiced liquor.
VIII.—Is the freshly made spirit kept any time before being put on the market? If so, for how long? State the rules, if any, governing this matter.	Ordinarily about a month, but there is no rule.

Presidency of Bombay, District Nasik.

I.—Name of distillery.	The Government Central Distillery, Nasik.
II.—What class of still is used, *i.e.*, pot-stills, goose-neck stills, fire-heated, steam-heated stills, etc. Describe the stills and state their approximate capacity.	The stills used in this distillery are goose-neck copper worm stills four in number, and furnace-heated. Steam power is not used. These four stills consist of large copper pans, with teakwood covers to which the goose-neck is attached. Their capacities are as follows:— Still No. I 1,680lbs. Still No. II 1,080lbs. Still No. III 1,080lbs. Still No. IV 1,080lbs.
III.—(*a*) Enumerate all the materials used in the preparation of the liquor.	Mhowra flowers, cold water and yeast.

(*b*) State the proportions in which these materials are used.	To every 240 lbs. pulla of mhowra flowers soaked in the hot weather 16 gallons of yeast and 32 gallons of cold water are used, and in the cold weather, to the same quantity of mhowra flowers 32 gallons of yeast and 16 gallons of cold water are used.
IV.—Describe fully the process or processes employed.	The mhowra after being weighed is soaked in vats in which cold water and yeast in the above proportions have already been placed, and allowed to remain there till fermentation is ripe, when it is removed and placed in the stills for distillation. During this time the mash is stirred twice during the hot, and from three to four times during the cold season.
V.—How long is the mash left fermenting :—	
(*a*) in the hot season ;	6 days.
(*b*) in the cold season.	7 to 8 days.
VI.—What time is allowed to elapse between the completion of fermentation and distillation ?	None.
VII.—What is the average strength (in terms of proof spirit) of the spirit taken from the receivers ?	The average strength of single distilled spirit is 50° U.P. The strength of double distilled spirit which alone is issued for consumption in the district is fixed and is 25° U.P. and 60° U.P.
VIII.—Is the freshly made spirit kept any time before being put on the market ? If so, for how long ? State the rules, if any, governing this matter.	The freshly made liquor is stocked and allowed to cool down before being issued from the distillery. No rules.

Bombay Presidency (District Khandesh).

I.—Name of distillery.	Dhulia Government Central Distillery (on the Chalisgaon-Dhulia Branch of the Great Indian Peninsula Railway).
II.—What class of still is used : *e.g.*, pot-stills, goose-neck stills, fire-heated, steam-heated stills, etc. Describe the stills and state their approximate capacity.	The class of still used in the steam-heated still with goose-neck. The still consists of a large wooden vat with a copper steam pipe arranged in a coil all along the bottom : the head of the vat is closed and a retort-like neck (made of copper) issues from it into the condenser. The wash when ready for distillation is lowered from the fermentation vats into the still and distillation is commenced by letting steam into the copper coil. The approximate capacity of the still is 15,600 lbs. of mhowra flowers.

III.—(*a*) Enumerate all the materials used in the preparation of the liquor.	Mhowra flowers, yeast and water.
(*b*) State the proportions in which these materials are used	To one pulla or 240 lbs. of mhowra flowers, 40 gallons of yeast (locally called "ghurra") and 65 gallons of river water are added.
V.—Describe fully the process or processes employed.	The wash is prepared according to the proportion given in No. III, and the mixture is stirred daily by means of a wooden stirrer in order to ensure a proper fermentation of each and every mhowra flower. Much depends on the proper stirring up of the wash, otherwise it may go bad and yield a poor outturn of spirit. When the wash is thoroughly fermented it is passed into the still and immediately distilled.
V.—How long is the mash left fermenting— (*a*) in the hot season; (*b*) in the cold season	The mash is usually ready for distillation in the hot season in 6 or 7 days and in the cold season in 8 or 9 days.
VI.—What time is allowed to elapse between the completion of fermentation and distillation?	No time.
VII.—What is the average strength (in terms of proof spirit) of the spirit taken from the receivers?	The average strength of single distilled spirit taken from the receiver is 53° U.P. The strength of double-distilled spirit which alone is issued for consumption in the district, is fixed and is 25° U.P. and 60° U.P.
VIII.—Is the freshly made spirit kept any time before being put on the market? If so, for how long? State the rules, if any, governing this matter.	Fresh spirit is ordinarily allowed to stand for a few days before being issued. No rules have been framed in this respect.

Presidency of Bombay, District Poona.

I.—Name of distillery.	Mundhwa Government Central Distillery near Poona, situated at a distance of $\frac{3}{4}$ mile from the Hadapsar Station on the Great Indian Peninsula Railway.
II.—What class of still is used, *e.g.*, pot-stills; goose-neck stills, fire-heated, steam-heated stills, etc. Describe the stills, and state their approximate capacity.	Both pot and goose-neck stills are used in the distillery, the former fire-heated are only used in cases of break-down and the latter steam-heated are usually in requisition. Three goose-neck (two for single distillation and one for double distillation purposes) stills are in general use. The capacity of each of the first two stills is 6,800 gallons and that of the third (re-distillation still) is 1,600 gallons.

	Two pot-stills of the capacity of 682 and 300 gallons respectively are kept as a stand-by in case of break-down of steam power.
III.—(*a*) Enumerate all the material used in the preparation of the liquor.	Mhowra, lees and water.
(*b*) State the proportions in which these materials are used.	To each pulla (240 lbs) of mhowra 35 to 40 gallons of lees and 60 to 65 gallons of water are added. Each soaking of mhowra varies from 35 to 50 pullas.
IV.—Describe fully the process or processes employed.	The mixture of mhowra, lees and water (lees are taken in the morning, water in the evening and mhowra put in the following morning) is placed in a vat and after a lapse of 24 hours is stirred twice a day until it arrives at a proper state of fermentation and fit for use.
V.—How long is the mash left fermenting— (*a*) in the hot season, (*b*) in the cold season.	Six days and seven days generally.
VI.—What time is allowed to elapse between the completion of fermentation and distillation ?	No time.
VII.—What is the average strength (in terms of proof spirit) of the spirit taken from the receivers ?	25° U.P. of double-distilled liquor which alone is issued for consumption in the district.
VIII.—Is the freshly made spirit kept any time before being put on the market ? If so, for how long ? State the rules, if any, governing this matter.	There are 16 vats for holding liquor for sale varying in capacity from 700 to 2,180 gallons, which are filled and emptied in rotation with the result that liquor is on an average 4 months in stock before it is placed on the market. There are no rules governing this matter.

Presidency of Bombay, District Satara.

I.—Name of distillery.	Government Central Distillery, Satara.
II.—What class of still is used, *e.g.*, pot-stills, goose-neck stills, fire-heated stills, etc. Describe the stills, and state their approximate capacity.	The kind of still used is goose-neck still, fire-heated. It consists of 3 parts, namely : (*a*) a copper vessel, called the boiler, imbedded in a masonry platform over the furnace ; (*b*) conical shaped wooden cover for the boiler at the top of which is riveted a goose-necked copper tube. This tube can be inserted into the third part called (*c*) the condensing worm which coils round in the condensing vat filled with water. Neither the boiler nor the worm is tinned. The approximte capacity of the still is 400 gallons.

III.—(*a*) Enumerate all the materials used in the preparation of the liquor.	(*a*) The materials used in the preparation of the liquor are mhowra flowers with yeast and water. On rare occasions the bark of the white "babul or hivar" tree and the leaves of the "nim" a kind of cinchona tree, are thrown in the mash the former, it is said, accelerates fermentation and the latter cuts acidity which prevents fermentation setting in.
(*b*) State the proportions in which these materials are used.	(*b*) The proportions in which these materials are used are (1) in the hot season 720 lbs. of mhowra flowers, 45 to 60 gallons of yeast and about 230 gallons of water; (2) in the cold season 720 lbs of mhowra flowers, 65 to 85 gallons of yeast and 200 gallons water. When proportions of babul bark and nim leaves, whenever used, are 30 lbs. of the former and only a handful or two of leaves of the latter for every 720 lbs. of mhowra flowers.
IV.—Describe fully the process or processes employed.	When all the liquor has been drawn, the contents of the still are emptied through a slide valve into a wooden box. This is then passed through a sieve; thus separating the mhowra flowers from the syrup, called yeast, which is collected in a vat and allowed to stand for about 12 hours. The yeast is then distributed into other vats mixed with water in the proportions given above. This mixture is again allowed to stand for about 24 hours, after which 720 lbs. of mhowra flowers are put in each vat. The mash is stirred up every morning and evening until fermentation subsides and the mixture cools down, when it is distilled before it becomes too sour. The liquor that is drawn from this mash is called single-distilled spirit and this has to be distilled over again; only double-distilled spirit of 25° U.P. being passed out of the distillery to be put on the market.
V.—How long is the mash left fermenting—	The mash is left fermenting for about
(*a*) in the hot season;	(*a*) 6 to 7 days in the hot season;
(*b*) in the cold season.	(*b*) 7 to 8 days in the cold season.
VI.—What time is allowed to elapse between the completion of fermentation and distillation.	From 24 to 36 hours on an average. Sometimes a number of vats are ready for distillation, but as there is only one still they are kept untouched for 2 and even 3 days.

VII.—What is the average strength (in terms of proof spirit) of the spirit taken from the receivers?	The average strength is 60° proof spirit per cent. in the case of single-distilled spirit and 80° to 85° in the case of double-distilled. This latter is diluted with pipe water and brought down to the authorized strength which is 75° proof spirit per cent., or 25° U.P.
VIII.—Is the freshly made spirit kept any time before being put on the market? If so, for how long? State the rules, if any governing this matter.	The freshly drawn spirit is kept in the distillery for about a month on an average, but there are no rules regulating this matter.

Presidency of Bombay, District Sholapur.

I.—Name of distillery.	Government Central Distillery, Sholapur.
II—What class of still is used, *e.g.*, pot-stills, goose-neck stills, fire-heated stills, etc. Describe the stills, and state their approximate capacity.	Goose-neck copper still, fire-heated. There are two stills of this kind, one smaller than the other. The capacity of one is enough to hold 800 lbs. of soaked mhowra flowers for the purpose of distillation ; while that of the other is sufficient for 250 lbs. only. The smaller one is used for re-distillation.
III.—(*a*) Enumerate all the materials used in the preparation of the liquor. (*b*) State the proportions in which these materials are used.	(*a*) Mhowra flowers soaked with water. In order to accelerate fermentation a little quantity of yeast is used. When distilling "Masala" liquor (Rose), rose-buds and liquorice roots are added to mhowra spirit. (*b*) The proportions of the ingredients used are as follows :— 31 gallons of water and 7 gallons of yeast to 100 lbs. of mhowra flowers. 60 lbs. of rose-buds and 20 lbs. of liquorice roots to 100 gallons of plain mhowra liquor.
IV.—Describe fully the process or processes employed.	First the wooden fermenting vat is scrubbed, washed with hot water, smoked and exposed to the sun. It is then filled with water in which the mhowra flowers yeast is mixed. The mixture is allowed to remain undisturbed for 24 hours. The mhowra flowers are then put into the mixture and allowed to ferment. The fermenting mixture is stirred twice a day morning and evening. When ready for distillation it is put into stills and the process of distillation begins. The liquor thus distilled is called single-distilled liquor. It is redistilled to 25° U.P.

V.—How long is the mash left fermenting—	
(*a*) in the hot season ;	For 4 days.
(*b*) in the cold season.	For 5 days.
VI.—What time is allowed to elapse between the completion of fermentation and distillation ?	No time.
VII.—What is the average strength (in terms of proof spirit) of the spirit taken from the receivers ?	The average strength of the single-distilled liquor taken from the receiver is 50° to 56° U.P. which when redistilled is brought down to 25° U. P. at which strength alone liquor is issued for consumption in this district.
VIII.—Is the freshly made spirit kept any time before being put on the market? If so, for how long ? State the rules, if any, governing this matter.	The freshly made spirit generally remains in the distillery for a fortnight or more according to the demand, before it is sent out. There are no rules governing the matter.

Bombay Presidency, District Belgaum.

I.—Name of distillery.	Government Belgaum, Central Distillery.
II—What class of still is used, *e.g.*, pot-stills, goose-neck stills, fire-heated, steam-heated stills, etc. Describe the stills and state their approximate capacity.	Goose-neck, fire-heated.
III.—(*a*) Enumerate all the materials used in the preparation of the liquor.	Mhowra flowers, molasses and dates (the two latter not being available at present, the former, *i.e.*, mhowra flowers only are used).
(*b*) State the proportions in which these materials are used.	They are all used separately.
IV.—Describe fully the process or processes employed.	The material (mhowra flowers) is first put into wooden fermenting vats for a period of 5 or 8 days according to hot or cold weather and mixed with yeast and water in the proportion of one part of the material (mhowra flower), one part yeast and two parts water. This fermented mash is immediately on the expiry of the above mentioned period emptied into the copper stills, heat is applied below it, which produces vapour from the material, the vapour is then condensed by being made to pass through the cold water in a copper worm and the liquid thus produced is what is termed single-distilled liquor. This single distilled liquor is re-distilled and made into "double-distilled liquor".

V.—How long is the mash left fermenting—	
(*a*) in the hot season;	For about 5 days.
(*b*) in the cold season.	For about 8 days.
VI.—What time is allowed to elapse between the completion of fermentation and distillation?	About 12 hours.
VII.—What is the average strength (in terms of proof spirit) of the spirit taken from the receivers?	The strength of double-distilled liquor is 25° U.P. at which alone liquor is issued for consumption in this district.
VIII.—Is the freshly made spirit kept any time before being put on the market? If so, for how long? State the rules, if any, governing this matter.	The liquor is kept for a period of at least two months before being put on the market. There are no rules governing this matter.

Presidency of Bombay, District Dharwar.

I.—Name of distillery.	Government Central Distillery, Dharwar.
II.—What class of still is used, *e.g.*, pot-stills, goose-neck stills, fire-heated, steam-heated stills, etc. Describe the stills, and state their approximate capacity.	Three stills of the goose-neck class, fire-heated, are in use. These are of copper and circular in shape, two having wooden covers and the third one entirely of copper. The capacity of the two larger stills is 750 gallons and that of the others 357 gallons.
III.—(*a*) Enumerate all the materials used in the preparation of the liquor.	Mhowra flowers or molasses when mhowra is dearer. The flavouring essence used on any rare occasions for making "masala" (spiced) liquor is orange peel.
(*b*) State the proportions in which these materials are used.	In each of the larger stills 1,640 lbs. of mhowra flowers or 1,000 lbs. of molasses are used, and in the smaller one, however, only 820 lbs. of mhowra flowers. Hitherto this still has not been used for the distillation of spirit from molasses.
IV.—Describe fully the process or processes employed.	On the first day a certain quantity of water and ferment is poured into the steeping vat, on the next the requisite quantity of mhowra flowers or molasses (as the case may be) is thrown in, and on the third and succeeding days the mash is agitated twice daily until it is fit for distillation.

V.—How long is the mash left fermenting—	
(*a*) in the hot season;	(*a*) Mhowra flowers from 3 to 4 and molasses from 4 to 5 days.
(*b*) in the cold season.	(*b*) The former from 5 to 6 and the latter from 6 to 7 days.
VI.—What time is allowed to elapse between the completion of fermentation and distillation.	As soon as the fermentation is ripe, the mash is distilled.
VII.—What is the average strength (in terms of proof spirit) of the spirit taken from the receivers?	The strength of double distilled liquor is 40° and 25° U.P. Spirit of 25° U.P. alone is issued for consumption in Dharwar district and that of 25° and 40° U.P. is issued for the above Ghat talukas of Kanara.
VIII.—Is the freshly made spirit kept any time before being put on the market? If so, for how long? State the rules, if any, governing this matter.	From one to one and a half months. No rules seem to have been made in the matter.

Presidency of Bombay, District Bijapur.

I.—Name of distillery.	Government Central Distillery, Bijapur.
II.—What class of still is used:—*e.g.*, pot-stills, goose-neck stills, fire-heated, steam-heated stills, etc. Describe the stills, and state their approximate capacity.	Pot-still. It consists of a boiler placed over the fire, a moveable head or cover with a swan-neck communicating with the worm which is a coiled tube placed in the worm tub, a vessel containing water kept constantly cold. It holds 280 gallons of liquor for distillation.
III.—(*a*) Enumerate all the materials used in the preparation of the liquor.	(*a*) Mhowra flowers.
(*b*) State the proportions in which these materials are used.	(*b*) One part mhowra and 3 parts water, *i.e.*, 588 lbs. of mhowra with 196 gallons of water is put in a vat for fermentation.
IV.—Describe fully the process or processes employed.	A furnace is built with brick and chunam. The boiler is placed over the fire. The fermented quantity of mhowra is put into the boiler and the moveable head with the swan-neck pipe is adjusted to the worm.
V.—How long is the mash left fermenting—	
(*a*) in the hot season;	6 days.
(*b*) in the cold season.	7 days.

VI.—What time is allowed to elapse between the completion of fermentation and distillation?	No time is allowed to elapse between completion of fermentation and distillation except that when fermentation is complete on any day distillation begins on the following day.
VII.—What is the average strength (in terms of proof spirit) of the spirit taken from the receivers?	Average strength of single-distilled liquor is always found to be between 53° to 55° U.P. This is re-distilled to 25° U.P. at which strength alone liquor is issued for consumption in this district.
VIII.—Is the freshly made spirit kept any time before being put on the market? If so, for how long? State the rules if any, governing this matter.	The liquor is not issued from the distillery till it has fully cooled and settled, which requires at least 3 days. There are no rules on this subject. According to the conditions of the license a stock of 1,500 gallons has to be kept on hand. One vat is kept for issue while a separate vat is kept to store fresh manufactured liquor.

Presidency of Bombay, District Ratnagiri.

I.—Name of distillery.	There are nine small public distilleries in this district, *viz.*, Vengurla, Malwan, Hadi, Rahatagar, Palshet, Dabhol, Anjarla, Ladghar and Guhagar. The last named is not working this year.
II.—What class of still is used, *e.g.*, pot-stills, goose-neck stills, fire-heated, steam-heated stills, etc. Describe the stills, and state their approximate capacity.	Fire-heated copper pot stills are used at all the distilleries except that of Vengurla, where a fire-heated goose-neck still is in use. The capacity of the stills varies from 30 to 76 gallons.
III.—(*a*) Enumerate all the materials used in the preparation of the liquor.	Toddy is the only material used in the preparation of the liquor.
(*b*) State the proportions in which these materials are used.	......
IV.—Describe fully the process or processes employed.	The still is heated over an oven built of laterite stones and mud. The copper pot which holds the toddy has two openings one at the top and the other at the side close to the neck. The top opening is firmly closed with a stone stopper and rags, after the toddy is put in. The toddy is heated to boiling point and then a joining pipe is firmly fixed between this and a second pot called the condenser. The vapour issuing from the heated toddy pot is condensed by pouring cold water constantly upon the condenser. The distiller knows by constant practice and by sounding

	the liquor receiver or condenser what amount of liquor is drawn. When he finds that the usual quantity is drawn, he quenches the fire in the oven and after a little while separates the joining pipe from the pots and removes the liquor to a separate pot and measures it. It is not tested until it sufficiently cools down. The whole process takes from 5 to 6 hours.
V.—How long is the mash left fermenting—	
(*a*) in the hot season;	For 2 or 3 days.
(*b*) in the cold season.	For 3 to 5 days.
	7 days in the rainy season.
VI.—What time is allowed to elapse between the completion of fermentation and distillation?	The Distillery Inspectors vary on this point but there seems no necessity of allowing any time to elapse between the completion of fermentation and distillation. The sooner distillation takes place after fermentation the better. The quantity and quality of the liquor produced suffers in proportion to the length of time allowed to pass between the completion of fermentation and distillation.
VII.—What is the average strength (in terms of proof spirit) of the spirit taken from the receivers.	The average strength of spirit taken from the receivers is 60° U.P. and 25° U.P.
VIII.—Is the freshly made spirit kept any time before being put on the market? If so, for how long? State the rules, if any, governing this matter.	The freshly made spirit is put on the market immediately after cooling (which requires about 12 hours) if there is demand for it. When there is no demand the liquor is kept for weeks or even months. No rules in this matter appear to have been framed or issued for guidance.

Presidency of Bombay, District Kanara.

I.—Name of distillery.	There are three small public distilleries in this district, *viz.*, Kodibag, Gangawali and Shirali.
II.—What class of still is used, *e.g.*, pot-stills, goose neck stills, fire-heated, steam-heated stills, etc. Describe the stills, and state their approximate capacity.	A round copper pot of the average capacity of from 60 to 65 gallons known in India as a 'handa.' It is tinned inside. The apparatus consists of a rounded hearth about 5 feet in circumference. Upon this hearth is firmly placed the copper 'handa.' On the handa is placed

	an earthen pot of broad mouth fitting with that of the big copper pot. The earthen pot is put upon the 'handa' inverted. The base of the earthen pot has a hole of 4 inches circumference. Further upon this inverted earthen pot is placed a peculiar shaped metal pot, the inner side of which is of the same form as that of the base of the earthen pot and from one of its inner sides a pipe protrudes. This is known as "sarpose." On the outer or convex side of this highest placed pot is a crude arrangement for a continuous fall of cold water which soon after leaves the apparatus by a side tube. Near by, a short distance off, cisterns (made locally of wood and open from above) containing cold water are placed which as above said supply a cooling water to the apparatus during distillation. The sides of the hearth and the 3 pots above it are hermetically closed, so as not to let the inside be affected by the outside air.
III.—(*a*) Enumerate all the materials used in the preparation of the liquor. (*b*) State the proportions in which these materials are used.	The only material used in the preparation of liquor here is toddy extracted from the cocoanut palm. No other substance, either intoxicating or extraneous, is ever mixed in the toddy, not even *aqua pura*.
IV.—Describe fully the process or processes employed.	Toddy brought by the various tappers is poured in the usual liquor cask in the first place. This toddy is fetched in the morning and the cask is generally full towards noon. A system called "Lambeit" of testing the purity of the toddy is instituted. The same apparatus still on a miniature scale is used for this. When the non-adulteration of the toddy is so tested, the cask full of toddy is rolled on near to the still, where in an adjoining room it is kept for two more days, in all; the toddy since its being lowered from the cocoanut palms remains in a state of fermentation for 3 days. On the morning of the fourth the contents of this cask of toddy are emptied in the big copper handa. The average capacity of this handa as described above is from 60 to 65 gallons. In this pot only 44 to 50 gallons of the fermented toddy is poured and after the pouring, the pots as detailed already, are adjusted and sealed with a native plaster of easy procurance. Cold water is ready and arrangements are made to have the supply continuous during the process. In the early morning all this is made and the hearth filled with fuel. Blazing fire is then kindled. The fire arrangement is perfect though crude: most of the heat is utilized and not allowed to waste. The only aperture open is stuffed with wood, while the sides are plastered. As the toddy in the pot is

heated its evaporation begins and issuing from the base hole of the inverted earthen pot comes in contact with the 'sarpose.' The concave side of the sarpose thus has the toddy steam, while the convex side is in perennial touch with a flow of cold water. The steam liquifies and passes out through the aperture described above. Water falling on the convex side of the sarpose is as described above allowed to pass on without remaining on it unnecessarily. This arrangement is specially made to allow the convex surface of the sarpose to be continually cool when by this heating and cooling process toddy steam equal in quantity to one-fourth of the contents originally put is liquified in a pot communicating with the apparatus, the fire is extinguished and we obtain liquor of first distillation. It is generally between 51° and 54° U.P. Any liquid refuse remaining in the handa is thrown away as useless. All alcoholic matter is already gone in the liquor. This liquor obtained by first distillation is kept in a strong room until a convenient time. No limit is observed. It generally depends upon the demand for liquor by the farmers. The process of second distillation is similar with the first. Only that in this, Richard Yates' Bombay Abkari tables are consulted. This pamphlet contains a series of figures which show how much liquor of a certain strength obtained in first distillation must be put to get liquor of 25° U.P., *e.g.*,

100 gallons of toddy liquor obtained in first distillation is measured at 52° U.P.

The tables show that 64 gallons of 25° U.P. will be obtained from these 100 gallons at the second distillation. When the liquor begins to pour in the outer jar and just measures 64 gallons the process closes, any residue in the copper pot being treated as a refuse tc be thrown away.

V.—How long is the mash left fermenting? (*a*) in the hot season; (*b*) in the cold season.	No time is generally allowed between fermentation and distillation. As remarked above the toddy is kept for three days to ferment before being brought to distil. In the rainy season this interval is raised to 4 or 5 days at most.
VI.—What time is allowed to elapse between the completion of fermentation and distillation?	Completion of fermentation coincides with distillation, no interval being allowed.
VII.—What is the average strength (in terms of proof spirit) of the spirit taken from the receivers?	Between 51° and 54 U.P. is the average strength of liquor of first distillation. There are two sorts of liquors obtained at second distillation in Kanara 40° U.P. and 25 U.P.

	The process of obtaining 25° U.P. is already described. That of obtaining 40° U.P. is exactly similar only that instead of obtaining 64 gallons from 100 in the example quoted against question No. 4, we must wait until we get 80 or $\frac{4}{5}$ of the number of gallons of 25° U.P., 80 gallons of 40° U.P. or 64 gallons of 25° U.P. are produced from a 100 gallons of 52° U.P. liquor.
VIII.—Is the freshly made spirit kept any time before being put on the market? If so, for how long? State the rules, if any, governing this matter.	This depends upon the demand. If the farmer asks for liquor immediately he gets it. If on the other hand no requisition comes from him the liquor remains in strong rooms until demand arises. The belief is that the longer the liquor remains in strong room the better in quality it becomes. There are no hard and fast rules. The only restriction is that the farmer must get liquor whenever he asks for it. The distillery is not worked by Government but has on its premises a Distillery Inspector who supervises the working on behalf of Government. The distillers are private men licensed to distil liquor under Government supervision. A rough sketch of the apparatus is appended.

A.

The process of distillation, as carried on in these distilleries, may be divided into two stages or operations. Fermentation and distillation. On the completion of a distillation the spent wash is run out of the still into a masonry receiver divided by a wooden sieve to separate the more solid matter from the liquid, which is reserved and used as the yeast or active principle for subsequent fermentation. This spent wash—the lees of feculencies of a former distillation—is first emptied into the fermenting vats, which have previously been thoroughly rubbed down, washed out, and fired to neutralise the acidity absorbed in the wood of the vats. Into the spent wash, which occupies about one-sixth of the capacity of the vat, water, to the extent of about $\frac{2}{3}$rds of the capacity of the vat, is run, and allowed to stand over for a day. After which the material for fermentation is steeped in the remaining $\frac{1}{6}$th part of the vat reserved for the displacement caused by the addition of the material. Fermentation then proceeds uninterruptedly for five or more days according to the season and the material undergoing this process, during which time the mash is stirred twice daily to disseminate the yeast, this process of stirring being particularly necessary with the fermentation of mhowra, which has a tendency to rise to the surface of the vat. On the completion of fermentation which is ascertained by either the use of the saccharometers or the primitive and generally recognised method of pressing the flower between the finger and the thumb to see if it will readily give and dissolve, when, it is said, to be sufficiently "attenuated" to undergo distillation, it is then emptied into the still with copper hundas, and as the steam or fire, as the case may be, is applied, the heated vapour rises and passes through the goose-neck into the worming of the condenser, which is supplied with a continuous flow of cold water. The condensed vapour, now spirit, is received in vessels provided for the purpose and then removed to the store-room. This process of fermentation and distillation is followed in all the distilleries and is substantially identical in each.

Presidency of Bombay, Town and Island of Bombay.

I.—Name of distillery.	Dadar Distillery.
II.—What class of still is used,—*e.g.*, pot-stills; goose-neck stills, fire-heated, steam-heated stills; etc. Describe the stills, and state their approximate capacity.	Pot-stills. The still consists of a copper boiler of the approximate capacity of 40 Imperial gallons and a copper receiver or a condenser, the approximate capacity of which is 25 gallons. The boiler and condenser are connected by a wooden tube generally made from the trunk of the betel-nut tree or ketki about four feet long, with an aperture of 3 or 4 inches in diameter. The boiler is set up in a clay furnace. The mouth of the boiler is plugged during distillation with a stone stopper and made air-tight with a piece of cloth covered with clay. One end of the hollow tube is fixed in a hole under the neck of the boiler and the other end is fixed into the mouth of the condenser. Both the ends are made air-tight. The condenser is set up on a wooden stand, below which a small reservoir made of stone to receive water is placed below the surface of the ground. The boiler and condenser are tinned before use and re-tinned when traces of copper are discovered in the liquor, which is discovered by putting in a few drops of a solution of ferro-cyanide of potassium into the glass containing liquor.
III.—(*a*) Enumerate all the materials used in the preparation of the liquor.	Only one material, *viz.*, toddy, is used. No other material is added to the toddy.
(*b*) State the proportions in which these materials are used.	To produce one gallon of toddy spirit of 25° U. P. about 6 gallons of raw toddy are used.
IV.—Describe fully the process or processes employed.	Fermented toddy is poured into the boiler which is set on the furnace. The vapoured spirit passes from the boiler into the condenser through the tube. The water from the reservoir below is poured on the condenser by one or two men with a ladle (made out of the cocoa-nut shell) incessantly until the vapour is condensed as liquor in the condenser.
V.—How long is the mash left fermenting:—	
(*a*) in the hot season;	3 days,
(*b*) in the cold season.	5 days.

VI.—What time is allowed to elapse between the completion of fermentation and distillation?	One day only.
VII.—What is the *average* strength (in terms of proof spirit) of the spirit taken from the receivers?	Two kinds of spirits are distilled at this distillery, one of 25° U.P. and the other of 60° U.P. At the first distillation spirit taken out varies from 40° to 60° U.P. and when redistilled it is taken out at 25° U.P.
VIII.—Is the freshly made spirit kept any time before being put on the market? If so, for how long? State the rules, if any, governing this matter.	Generally it is kept for a few days and not for any length of time. There are no rules governing this matter.

PRIVATE DISTILLERIES
AT
MORA
(ON THE OTHER SIDE OF BOMBAY HARBOUR).

Statement as regards all the Distilleries situated at Mora, with reference to letter No. 5474, dated 30th August 1904, from the Government of India.

1	2		3		4	5		6	7	8	
Name of distilleries.	Class of stills used.		Materials used. (a)	Proportion of these materials used. (b)	Description of process employed.	Time, Mash left fermenting.		Time between completion of Fermentation and Distillation.	Average strength from Receiver.	How long is the freshly made spirit kept before being put on the market.	Rules if any.
	Description of still.	Approximate Capacity.				Hot season.	Cold season.				
No. 1	......	Not worked.									
No. 3 A	2 copper pot-stills, with goose-neck, fire-heated.	(1) 182 gallons for redistillation. (2) 350 gallons.	Weak spirit, Mhowra or dates.	182 gallons ... 720 lbs. ... 800 lbs. ...		5 days ... 6 " ...	6 days ... 3 " ...	2 hours ...	53° U.P. singledi-stilled 21° U.P. double-distilled	2 to 3 days if urgently needed ordinarily from 12 to 15 days.	*Nil*
No. 2	2 copper pot-stills, with goose-neck, fire-heated.	(1) 250 gallons ... (2) 400 " ...	Weak spirit, Mhowra or dates.	250 gallons ... 800 lbs. ... 800 lbs. ...	*Vide* attached Memorandum A.	5-6 days ... 6-7 " ...	5-6 days ... 8-9 " ...	40 minutes ...	45° U.P. single-distilled 19° U.P. double-distilled	at least 15 days.	*Nil*
No. 3	2 copper pot-stills, with goose-neck, fire-heated.	(1) 400 gallons ... (2) 600 " ...	Mhowra or dates or raisins. Mhowra.	800 lbs. ... 1,200 lbs. ...		Mhowra 5 days ... Dates 7 days, raisins 8 days.	Mhowra 6-7 days ... Dates 8 days ... Raisins 10-11 days	45 minutes ...	50° U.P. single-distilled 23° U.P. double-distilled	About 8 days.	*Nil*
No. 4	2 copper pot-stills, with goose-neck, fire-heated.	(1) 350 gallons ... (2) 900 " ...	Mhowra, or dates or raisins or jaggery. Mhowra ...	800 lbs. .. 2,000 lbs. ...		Mhowra 5 days ... Dates 6 days ... Raisins 10 days ... Jaggery 14 days. ...	Mhowra 7 days ... Dates 9 days ... Raisins 12 days ... Jaggery 16 days ...	40 minutes small still 1½ hours large still	48° U P. single-distilled 21° U.P. double-distilled	About 3 days.	*Nil*
No. 5	2 copper pot-stills, with goose-neck, fire-heated.	(1) 350 gallons ... (2) 1050 " ...	Mhowra ... " ...	800 lbs. ... 2,400 lbs. ...		5 days ...	6 days ...	About 1½ hours ...	47° U.P. single-distilled 25° U P. double-distilled	About 8 days.	*Nil*
No. 6	2 copper pot-stills, with goose-neck, fire-heated.	(1) 500 gallons ... (2) 750 " ...	Mhowra or dates ... Ditto ...	1,300 lbs. ... 1,600 lbs. ...		6 days ... 7 " ...	7 days ... 8 " ...	Mhowra 1 hour ... Dates 1½ " ...	45° U.P. single-distilled 20° U.P. double-distilled	About 8 days.	*Nil*

1	2		3		4	5		6	7	8	
Name of Distilleries.	Class of stills used.		Materials used (a).	Proportion of these materials used (b).	Description of process employed.	Time, Mash left fermenting.		Time between completion of Fermentation and Distillation.	Average strength from Receiver.	How long is the freshly made spirit kept before being put on the market.	Rules if any.
	Description of still.	Approximate Capacity.				Hot season.	Cold season.				
No. 7	2 copper pot stills, with goose-neck, fire-heated.	(1) 350 gallons ...	Mhowra or dates ..	800 lbs. ...	*Vide* attached Memorandum A.	Mhowra 6 days ...	Mhowra 7 days ...	1½ hours... ...	37° U.P. single-distilled	About 8 days.	*Nil*
		(2) 350 ,, ...	Ditto ...	800 lbs. ...		Dates 6 days ...	Dates 7 days ...		19·5° U.P. double-distilled.		
No. 8	1 Rectifier ...	(1) 400 gallons ...	Weak spirit Mhowra	400 lbs. ...		Mhowra 5 days ...	Mhowra 7 days ...	8 to 10 hours ...	50° U.P. single distilled 22° U.P. double-distilled 60° U.P. spirits of wine.	24 hours if necessary; ordinarily 15 to 20 days.	*Nil*
	3 wooden steam-stills with goose-necks.	(1) 7,000 ,, ...	Ditto	16,000lbs. ..							
		(2) 5,000 ,, ...	Ditto	12,800 lbs. ...							
		(2) 3,900 ,, ...	Ditto								
	2 copper pot-stills, with goose-neck, steam-heated.	(1) 200 ,, ... (2) 100 ,, ...	Mhowra or dates ...	3,000 gallons ...		Dates 6 days ...	Dates 8 days ...				
				200 ,, ...		Raisins 7 days ...	Raisins 9 days ...				
				100 ,, ...		Jaggery 10-11 days	Jaggery 15-20 days				
	1 copper pot-stills, with goose neck fire-heated.	(1) 1,100 ,, ...	Raisins or Jaggery	2,400 ,, ...							
No. 10	2 copper pot-stills, with goose-necks, fire-heated.	(1) 350 gallons ...	Mhowra ...	800 lbs. ...		5 days ...	6 days ...	1 hour ...	45° U.P. single-distilled	About 20 days ...	*Nil*
		(2) 350 ,, ..	Dates ...	800 lbs. ...		6 ,, ...	7 ,, ...	2 hours ...	22° U.P. double-distilled		
No. 11	2 copper pot-stills, with goose-necks, fire-heated.	(1) 350 gallons ...	Mhowra ...	720 lbs. ...		5 days ...	6 days ...	45 minutes ...	50° U.P. single-distilled	24 hours if necessary, ordinarily 15 days.	*Nil*
		(2) 350 ,, ...	Dates ...	720 lbs. ...		6 ,, ...	7 ,, ...		19° U.P. double-distilled		

No. 12	2 copper pot stills, with goose-necks, fire-heated.	(1) 500 gallons ... (2) 750 ,, ...	Mhowra or dates ... Ditto ...	1,200 lbs. ... 1,600 lbs. ...		Mhowra 5 days ... Dates 6 days ...	Mhowra 6 days ... Dates 8 days ...	About 1 hour ...	48° U.P. single-distilled 21° U P. double-distilled	About 15 days ...	*Nil*
No. 13	2 copper pot-stills, with goose-necks, fire-heated.	(1) 350 gallons ... (2) 750 ,, ...	Mhowra or dates or raisins. Mhowra ...	800 lbs. ... 1,600 lbs. ...		Mhowra 5 days ... Dates 6 days ... Raisins 5 days ...	Mhowra 6 days ... Dates 7 days ... Raisins 6 days ...	45 minutes ...	50° U P. single-distilled 19° U.P. double-distilled	24 hours if necessary, ordinarily 15 days.	*Nil*
No. 14	2 copper pot-stills, with goose-necks, fire-heated.	(1) 350 gallons ... (2) 750 ,, ...	Mhowra or dates ... Mhowra ...	800 lbs. ... 1,600 lbs. ...		Mhowra 5 days ... Dates 7 days ...	Mhowra 6 days ... Dates 8 days ...	About 1½ hours...	50° U.P. single-distilled 19° U.P. double-distilled	About 15 days ...	*Nil*
No. 15	2 copper pot-stills, with goose-necks, fire-heated.	(1) 350 gallons ... (2) 350 ,, ...	Mhowra or dates ... Ditto ...	800 lbs. ... 800 lbs. ...		Mhowra 5 days ... Dates 6 days ...	Mhowra 6 days ... Dates 7 days ...	1¼ hours ...	50° U P. single-distilled 20° U P. double-distilled	About 12 days ...	*Nil*
No 16		Not worked.									
No. 17	2 copper pot-stills, with goose-necks, fire-heated.	(1) 350 gallons ... (2) 350 ,, ... (3) 350 ,, ...	Mhowra or dates	800 lbs. ...		Mhowra 5 days... Dates 6 days ...	Mhowra 6 days ... Dates 7 days ...	About 1½ hours...	45° U.P. single-distilled 25° U.P. double-distilled	About 8 days ...	*Nil*
No. 18	2 wooden steam-stills with goose-necks. 2 copper pot-stills, with goose necks, fire-heated.	(1) 7,500 gallons ... (2) 1,100 ,, ... (1) 350 ,, ... (2) 750 ,, ...	Mhowra ... Weak spirit ... Mhowra or dates or raisins. Mhowra ...	12,000 lbs. ... 1,100 gallons ... 800 lbs. ... 1,600 lbs. ...		Mhowra 6 days ... Dates 5 days ... Raisins 5 days ...	Mhowra 7 days ... Dates 6-7 days ... Raisins 6 days ...	2½ hours large still ... 1 hour small still ... 45 minutes pot-still ...	47° U.P. single-distilled 23° U.P. double-distilled	About 8 days ...	*Nil*
No. 19	3 wooden steam-stills with goose-neck. (1) Copper pot-still with goose neck, fire-heated.	(1) 7,500 gallons... (2) 7,500 ,, ... (3) 1,100 ,, ... (1) 750 ,, ...	Mhowra ... Do. ... Weak spirit ... Mhowra or dates ...	11,200 lbs. ... 11,200 lbs. ... 1,100 gallons ... 1,600 lbs. ...		Mhowra 5 days ... Dates 6 days ...	Mhowra 6 days ... Dates 7 days ...	2 hours large still ... 1 hour pot-still ...	45° U.P. single-distilled 20° U.P. double-distilled	About 15 days ...	*Nil*

BENGAL.

No. 1984-T.F., dated Darjeeling, the 20th October 1904.

From—L. P. SHIRRES, Esq., I.C.S., Secretary to the Government of Bengal, Financial Department,

To—The Secretary to the Government of India, Finance and Commerce Department.

I am directed to acknowledge the receipt of Mr. Campbell's letter No. 5474-S.R., dated the 30th August 1904. on the subject of the deputation of Major C. H. Bedford, Indian Medical Service, Chemical Examiner to this Government, for the purpose of conducting an enquiry into the quality of the country spirit sold in India. The Government of India request to be furnished with certain information in respect of each distillery in Bengal and with a list of the typical distilleries which should be visited by Major Bedford in connection with his investigation.

2. In reply I am directed to submit, for the information of the Government of India, a copy of a letter from the Board of Revenue, No. 173-B-T., dated the 6th October 1904, giving cover to a statement prepared by the Commissioner of Excise, Bengal, embodying the information required by the Government of India in respect of the several distilleries in Bengal. The Lieutenant-Governor agrees with the Board in thinking that the distilleries mentioned in the margin of paragraph 2 of their letter may be visited by Major Bedford in connection with the enquiry.

No. 173-B. T., dated Darjeeling, the 6th October 1904.

From—H. F. SAMMAN, Esq., Officiating Secretary to the Board of Revenue, Lower Provinces,

To—The Secretary to the Government of Bengal, Financial Department.

With reference to Government Order No. 1250-T.F., dated the 10th September 1904, and its enclosures, I am directed to submit, herewith, a statement, prepared by the Commissioner of Excise, Bengal, embodying the information required by the Government of India in respect of the several distilleries in Bengal.

2. The Board agree with the Commissioner of Excise in thinking that the distilleries, noted in the margin, may be profitably visited by Major Bedford, but that should there not be sufficient time Gaya, Jessore and Midnapur distilleries may be omitted.

(1) Russa, (2) Patna, (3) Gaya, (4) Jessore, (5) Burdwan, (6) Midnapore, (7) Faridpur.

ame of illery.	Distance from Railway Statioo.	Number of stills.	Class of stills used.	Approximate capacity.	Materials used.	Proportion of materials in every maund.	Process or processes employed.	E PERIOD FOR WHICH THE WASH IS LEFT FERMENTING.		Time allowed to elapse between the completion of fermentation and distillation.	Average strength (in terms of proof spirit) of the spirit takeo from the receiver.	The period for which freshly made spirit is kept in store. Rules governing the matter.
								he hot season.	In the cold season.			
ahal al par-	Withio one mile from the Rajmahal Railway Station, East Indian Railway (Loop Line).	4 pot-stills 2 Rassa pattern stills.	4 pot-stills and 2 Rassa pattern stills (goose-neck) heated with coal.	Capacities of pot-stills range between 80 and 84 gallons and those of Rassa pattero stills 216 aod 250 gallons.	Mohwa and molasses ...	One maund mohwa to 3 seers of molasses.	13⅓ seers of mohwa are put in each vat. The constituents of the wash are— Mohwa ... ... 13⅓ seers. Water ... ... 7½ gallons. Spent-wash ... ... 2 „ Aetive wash ... ... 1½ „ On the first day active wash, called loban, is prepared with three seers of molasses, six gallons of spent-wash and six gallons of water and fermentation is set in it. On the second day after each vat being charged with 13⅓ seers of mohwa and about five gallons of water, one-third of the active wash (loban) prepared on the previous day is put in. The wash is stirred up daily on the 2nd, 3rd, and 4th day.	to 7 days ...	10 to 12 days ...	1 to 6 hours	50° U.P.	Liquor is issued according to the demand. When the stock of liquor is small, fresh liquor is issued otherwise it is kept in store. Liquor of about a month old at the most is kept in store. There is n rule goveroing the matter.
ntal ganas).	Withio one mile from the Pakoor Railway Station, East Indiao Railway (Loop Line).	3	Pot-stills heated with coal ...	Varying from 54 gallons to 104 gallons.	Mohwa and molasses ...	One maund of mohwa to 3 seers of molasses.	13⅓ seers of mohwa are put in each vat of 15 gallons liquid, capacity on an average. The constituents of the washare :— Mohwa ... ... 13⅓ seers. Water ... ... 6 gallons. Spent-wash ... ... 3 „ Loban or active wash ... ... 1¾ „ On the first day loban or active wash is prepared from three seers of molasses, six gallons of water and three gallons of spent-wash, each vat being charged with 13⅓ seers of mohwa, 4 gallons of water, 2 gallons of spent-wash. One-third of the loban or active wash noted above is put. On the 2nd or 3rd day the wash is well stirred up.	to 5 days ...	The distillery has been recently opened. It cannot now be stated how long it will take to ferment in winter.	1 to 6 hours	50° U.P.	Liquor is issued according to the demand. When the stock of liquor is small, fresh liquor is issued, otherwise it is kept in store. Liquor of about a month old at the most is kept in store. There is no rule governing the matter.
...	3 miles from the Cuttack Station (Bengal-Nagpur Railway).	3	Pot-stills, fire-beated with coil pipes condensers.	76 gallons	Rice	(*a*) 20 seers of full boiled rice and (*b*) 20 seers caked rice (prepared with 3 chittaks of bakhar) (*c*) 20 gallons of water.	20 seers of rice are placed in two jars, each holding 10 seers. The rice is half-boiled or rather steamed, the steam entering the jar through a hole (partly covered) at the bottom of the jar. When the rice is sufficiently softened or steamed it is spread on the floor of the still shed and mixed with bakhar (3 chittaks of this substance with 20 seers of half-boiled rice). The rice is then placed in baskets and the baskets are conveyed to the drying shed and placed on a platform. It is kept in the shed a whole night. The next morning it is found to have acquired a certain temperature. It is then measured out, 12 chittaks at a time, and spread in the form of cakes on the platform. For four days the cakes remain on the platform. On the 5th day they are taken up and turned. On the 11th or 12th day the caked rice is ready and 20 seers of it with 20 gallons of water are placed together in a fermenting jar and on the following day 20 seers of fully boiled rice are added. The whole process described takes about three to four weeks.	to 12 days ...	12 to 16 days ...	No time allowed	At the first draw 12° U.P. „ second draw 56° U.P.	Spirit of one day's manufacture is taken out for sale on the next day. There is no rule governing the matter.
sore ...	Within one mile from the Balasore Railway Station (Bengal-Nagpur Railway).	2	Copper-still of the country pattern ; fire-heated.	56 gallons and 61 gallons ...	Rice and bakhar	*20 seers of half-boiled rice* mixed with 10 gandas of bakhar (weighing about 3 chittaks) and 20 seers of *full boiled atap rice.*	Rice is first boiled in steam and after being cooled is mixed with bakhar. Then for a day it is kept in a basket; subsequently the rice is spread on a platform in the drying shed and kept there from 9 to 12 days to form into cakes which is then put into a vat with 10 gallons of water. Next day full boiled *atap* rice is added. Then it is allowed to ferment till it is ripe for distillation.	to 9 days ...	9 to 12 days ...	Ordinarily no time is allowed...	The strength varies from L.P. to 72° U.P. The average strength comes to about 30° U.P.	Spirit of different fixed strengths is stored in casks from day to day from which necessary quantities are issued, the balance being allowed to remain in store till it is removed in a day or two. There is no rule governing the matter.
...	One mile from the Puri Railway Station (Bengal-Nagpor Railway).	3	Fire-heated pot-still of country pattern.	43 to 65 gallons	Aroa rice and bakhar ...	20 seers of half-boiled rice, 20 seers of boiled rice, 3 chittaks of bakhar.	Half-boiled aroa rice is mixed with bakhar for the purpose of making cakes. The cakes are kept in the open air for 5 days in summer and 7 days in winter. They are then put into the vat, 24 gallons of cold water is poured in and next day 25 seers of boiled rice are added. The load of each vat is allowed to ferment for 6 to 14 days in summer and 10 to 18 days in winter. After the fermentation is complete the wash is put into the still for distillation.	6 to 14 days ...	10 to 18 days ...	No time allowed	37° U.P.	Freshly made spirit is stored in the godown before being issued. There is no fixed period for which it is to be kept in the godown. It is issued when there is a demand. There is no rule governing the matter.
... aribagh)	2 miles from the Giridih Railway Station (East Indian Railway).	4	Fire-heated pot-stills of the country pattern.	80, 129, 108 and 132 gallons, respectively.	Mohwa and gur	(*i.e.*, 35 seers of mohwa to 5 seers of gur).	Wooden casks are used as fermenting vats. They are loaded with mohwa and gur in the proportion of 7 : 1 with about 27 gallons of water, 3 gallons of spent-wash, and ¾ gallon of active wash. The proportion is thus 4 seers of materials to 3 gallons of liquid wash. When the fermentation is complete, the wash is put into the still. It is placed on a furnace and the still-head is hermetically closed to the mouth of the still and the tube or the delivery-pipe connecting the still-head with the receiver. On the application of fire, vapour generated in the still comes in contact with the concave part of the still-head which is kept cool hy means of a continuous flow of cold water, and is condensed into liquor. It flows down into the receiver through the delivery-pipe.	3 to 5 days ...	6 to 8 days ...	No time is allowed ...	Average strength of spirit varies from 45° to 60° U.P. when no water is placed into the receiver prior to distillation.	Generally speaking the daily outturn of liquor in the distillery here is issued on the same day, exeept on rare occasions when a small quantity remains in store. There is no rule governing the matter.

AMBICA CHARAN MUKERJEE,
Personal Assistant,
for *Commissioner of Excise and Salt, Bengal.*

Name of distillery.	Distance from Railway Station.	Number of stills.	Class of stills nsed.	Approximate capacity.	Materials used.	Proportion of materials in every maund.	Process or processes employed.	The period for which the wash is left fermentino.		Time allowed to elapse between the completion of fermentation and distillation.	Average strength (in terms of proof spirit) of the spirit taken from the receivers.	The period for which freshly made spirit is kept in store. Rules governing this matter.
								In the hot season.	In the cold season.			
arbhanga Distillery.	Within a mile from the Lahoria Serai Railway Station.	8	6 Pot-stills ... ... 1 Goose-neck still. 1 do. of Rassa pattern. All these stills are heated by direct contact with the fire.	75, 140, 128, 120, 70 and 123 gallons. 242 gallons. 124 "	Gur (molasses) and mohwa ...	10 seers gur ... ... 30 seers mohwa ...	Broad and open mouthed earthen jars buried in the ground and wooden casks with their tops removed are used as fermenting vats prior to the day the mohwa is put into the vats kasounjee is prepared. This process consists in putting into the vat water, spent-wash, gur. and active wash in the following proportion in a maund of materials to be used:— Water ... ... 20 gallons. Spent-wash ... ... 20 " Active ferment ... ... 1 gallon. Goor ... ... 10 seers (if mixed materials). During winter more spent-wash is used and the quantity of water is proportionately reduced. When the kasounjee is in full fermentation 30 seers of mohwa are put in on the following day for every maund of material.	Mixed materials 4 to 5 days. Gur 7 to 9 days.	Mixed materials 5 to 7 days. Gur 9 to 12 days.	Generally fermentation is completed in the night previous to the day of the distillation when the attenuation in the wort ceases and the minimum density is reached.	Average strength 54° U.P. which comes to 46 proof spirit.	Liquor is issued mostly on the very dey of distilletion. There are no rules regulating this matter.
nghyr ...	Within one mile from the Monghyr Railway Station, East Indian Railway (Loop Line).	5	Fire-heated, Rassa pattern stills.	The capacities vary from 244 to 520 gallons.	Mohwa and choa or molasses (cane gur from which sugar has been extracted) are used in distillation, aniseed is used in scenting proof liquor.	The proportion of mohwa to choa is as 3: 1.	On the day preceding the day of loading the vats with mohwa, a maund of choa is put in a cask and mixed with 8 gallons of spent-wash and 24 gallons of water and a gallon of active wash taken from the fermenting jars. The mixture is thoroughly stirred and allowed to ferment for at least 24 hours. This preparation is technically called labon, or yeast and is added in equal proportion on the day following to 3 maunds of mohwa distributed in 4 vats after the mohwa has been soaked in water for about 4 hours. The 4 casks contain 96 gallons of water. On the next morning 16 gallons of water and 16 gallons of spent-wash are again added to the 4 vats, so that each contains 40 gallons of water and spent-wash, 30 seers of mhowa and 10 seers of choa. The materials are then thoroughly mixed up. The mixture is occasionally stirred to facilitate fermentation. A small quantity of water, about half a gallon, is added to each cask every day to dissolve the acids formed.	4 to 6 days in summer.	6 to 8 days in winter.	If there is one distillation, the wash is generally distilled as soon as fermentation has been completed, but when 2 or 3 distillations are made on the same day in one still 3 or 6 hours elapse between completion of fermentation and distillation.	The average strength is 54° U.P.	The spirit is generally kept in store from 2 to 6 days. There is no rule on the subject but the liquor is ordinerily issued according to date of mnnufacture, tho oldest being issued first.
agalpur...	One mile from the Bhagalpur Railway Station, East Indian Railway (Loop Line).	8 (4 Rassa pattern stills and 4 country pattern stills).	Pot-and goose-necked stills (of Rassa pattern) are used in this distillery, all heated by fire.	The approximate capacity of the pot-still is 100 gallons and that of the Rassa pattern still is 200 gallons.	Only mohwa is used here ...	Mohwa	Mohwa mixed with water (10 seers mohwa and 10 gallons water) is allowed to soak in an earthen vessel, ¼th gallon of active wort is added to facilitate fermentation. In cold season, however, 2 gallons of spent-wash are mixed in addition to the active wash.	5 days on an average.	8 days on an average.	Fermented wort is immediately taken out for distillation. It is distilled on the very day the fermentation ceases.	60° U.P. is the average strength of the spirit taken from the receiver.	Freshly made spirit is generally issued to the licensed shops. There is no specified rule governing this matter.
umka Sonthal [illegible]).	38 miles from the Rampurhant Railway Station, East Indian Railway (Loop Line).	4	Fire-heated pot-stills of the conntry pattern.	43 to 96 gallons	Mohwa	Mohwa	20 seers of mohwa are put in each vat of 20 gallons liquid capacity. The constituents of the wash are as follows:— Mohwa ... ... 20 seers. Spent-wash ... ... 4 gallons. Water ... ... 9 " Active wash ½ gallon. Spent-wash is put in first and afterwards mohwa and water. About an hour after the mohwa is put in half a gallon of active wash is added to accelerate fermentation. On the 2nd day the wash is stirred. After the stirring it is no more disturbed before its removal to the still.	3 to 5 days ...	6 to 10 days ...	1 to 6 hours	50° U.P.	Liquor is issued according to the demand. When the stock of liquor is small, fresh liquor is issued, otherwise it is kept in store. Liquor of about a month old at the most is kept in store. There is no rule governing the matter.
odda Sonthal [illegible]).	30 miles from the Ghoga Railway Station, East Indian Railway (Loop Line).	4	Fire-heated pot-stills of the country pattern.	72 to 76 gallons	Mohwa	Mohwa	13½ seers of materials (mohwa) are put in each vat of 15 gallons liquid capacity. The constituents of the wash are:— Mohwa ... ... 13½ seers. Water ... ... 12 gallons. Active wash ½ gallon. During the cold season instead of 12 gallons of water 8 gallons of water and 4 gallons of spent-wash are put. On the 1st day mohwa and water are put together, ½ gallon of active wash being added to set in fermentation. The vats are stirred twice daily before the fermentation ceases.	4 to 6 days ...	6 to 10 days ...	1 to 6 hours	50° U.P.	Liquor is issued according to the demand. When the stock of liquor is small, fresh liquor is issued, otherwise it is kept in store. Liquor of about a month old at the most is kept in store. There is no rule governing the matter.
eoghar Sonthal [illegible]).	Within one mile from the Deoghar Railway Station, East Indian Railway.	3	Fire-heated pot-stills ...	Varying from 52 to 73 gallons	Mohwa	Mohwa	20 seers of mohwa are put in each vat of 20 gallons liquid capacity; the constituents of the wash are:— Mohwa ... ... 20 seers. Water ... ... 12 gallons. Spent-wash ... ... 4 " Active wash ½ gallon. Mohwa water and spent-wash are put together; half a gallon of active wash is added to set in fermentation. On the 2nd day the wash is stirred once.	3 to 5 days ...	6 to 8 days ...	1 to 6 hours	50° U.P.	Liquor is issued according to the demand. When the stock of liquor is small fresh liquor is issued; otherwise it is kept in store and liquor of about a month old nt the most is kept in store. There is no rule governing the matter.

	Distance from Railway Station.	Number of stills.	Class of stills used.	Approximate capacity.	Materials used.	Proportion of materials in every maund.	Process or processes employed.	THE PERIOD FOR WHICH THE WASH IS LEFT FERMENTING.		Time allowed to elapse between the completion of fermentation and distillation.	Average strength (in terms of proof spirit) of the spirit taken from the receivers.	The period for which freshly-made spirit is kept in the store. Rules governing the matter.
								In the hot sason.	In the cold season.			
–	3 miles from the Bankipur Railway station at Kumrar.	17	Fire heated Rassa pattern stills are in use except one in which the wash is heated by steam. The Rassa pattern still consists of— (1) a retort or still; (2) a still head; (3) a conduct pipe; (4) a refrigerator; (5) a receiver. The conduct pipe enters the refrigerator and forms the condensing coil or worm and comes out of it as delivery pipe, which is connected with the receiver. There is another smaller pipe through which flows luke-warm water from the refrigerator to the still head and effects partial condensation and rectification of the mixed vapour. The refrigerator is supplied with water from an overhead reservoir by means of a pipe which enters it at the bottom. It has got another pipe for the outlet of waste water. The steam-still is supplied with steam by the boiler which works the pumps for drawing water from the wells. The steam inlet pipe bifurcates before entering the retort one part of which is connected with the heating coil and comes out at the bottom as the outlet of waste steam and the other opens out into the retort and is used for the purpose of heating the wash by injection before the distillation is finished. Some of the stills have been provided with a rectifier for the elimination of noxious volatile oils which liquify at high temperatures. It consists merely of an independent chamber formed by the bulging out of a portion of the conduct pipe, and is covered over with a piece of gunny cloth which is kept moist by means of a flow-pipe from the refrigerator. This rectifier has one great drawback, *viz.*, it causes great delay in distilling liquor.	The capacities vary from 175 gallons to 615 gallons. The aggregate capacity of the stills is 5,376 gallons.	MATERIALS. (1) Mohwa flower (Bassia Latifolia). (2) Gur, molasses. (3) Chhoa (*i e.*, uncrystallisable syrup which comes out in the process of manufacture of sugar.	MIXED MATERIAL. Mohwa ... 30 seers. Chhoa ... 10 seers. PURE GUR. Gur, ... one maund. (To every maund of material, 2 gallons of active wash, 12 gallons of spent wash and 18 to 20 gallons of water are added.)	The fermentation is carried on in earthen vats, buried in the ground, each vat generally containing 20 seers of material. Water, spent-wash and chhoa (or gur) are put into the vat, and the mixture is thoroughly stirred with the hand. This is generally done in the morning. In the afternoon active wash is added and on the next morning mohwa is put into the vat. Fermentation generally commences about 3 hours after the addition of the active-wash but becomes less brisk for an hour or two after the mohwa is added. Fermentation goes on briskly till it is completed when all activity stops altogether. As fermentation goes on, the quantity of liquid matter in the wash decreases and small quantities of water are added from time to time to make up the dryage. When the fermentation is complete the wash is taken out of the vat and carried to the still-shed, where it is distilled in the stills.	In case of mixed material to 5 days. In case of pure gur 10 to 13 days.	In case of mixed material 6 to 7 days. In case of pure gur 14 to 17 days.	As soon as the fermentation is complete the wash is distilled. As a rule not more than 12 hours is allowed to elapse between the completion of fermentation and distillation. Completely fermented wash deteriorates if not distilled within 24 hours.	The average strength at which spirit is drawn from the receivers is 50° U. P.	Weak liquor of the strengths of 86° and 70° U.P. is generally passed out on the day it is distilled or on the next day as it loses its strength and taste after 3 or 4 days in the hot season and 5 or 6 days in the cold season. Liquor of 65° U. P. strength will keep for 10 or 15 days in summer and 3 to 4 weeks in winter. Liquor of 44° U. P. strength will keep for 3 months and L. P. for a year if proper care is taken. The strong liquor rather improves and becomes wholesome if kept for a long time. There is no rule regarding the time for which the liquor manufactured at the distillery is to be kept in the store room before issue.
–	2 miles from the Gaya Railway station.	12	There are 9 goose-neck stills known as Rassa stills, 2 pot stills made of copper and 1 French still.	The capacities of the Rassa stills range from 210 gallons to 315 gallons. The liquid capacity of pot stills is 110 gallons. Each of them (pot-stills) can work off 2 maunds of materials at a time. The liquid capacity of the French still is 99 gallons and its working capacity is 1½ maunds.	Mohwa flower and cane gur.	(1) Mohwa, 36 seers, cane gur, 4 seers. (2) Cane gur, 40 seers. (1) In every maund of material consisting of 36 seers of mohwa and 4 seers of cane gur, 2 gallons of spent wash, ½ gallon of active wash and 22 to 24 gallons of water are added. (2) In a maund of cane gur 6 gallons of spent wash, 2 gallons of active wash and 22 to 24 gallons of water are added.	In the case of mixed materials the gur is put into the vat one day before in order to allow it to dissolve completely in water. The process is to dissolve the gur first and then add mohwa. The hard gur is completely mixed with water before fermentation commences. The admixture (*i.e.*, wash under going fermentation) sets in fermentation. During the period of fermentation the wash has to be stirred daily at least once.	(1) Mohwa 5 to 7 days. (2) Pure cane gur 13 to 17 days.	(1) Mahwa 7 to 9 days. (2) Pure cane gur 17 to 22 days.	About 12 hours time is allowed to elapse between the completion of fermentation and distillation.	Liquors are issued from this distillery at 5 different fixed strengths, *viz.*, 10° U.P., 50° U.P., 70° U.P. 78° U.P., and 84° U.P. The liquors of the last 3 strengths are obtained *by the addition of* water to the actual distillate which is generally of the average strength of 63° U.P. The strong liquors of 10° U. P. and 50° U. P. are drawn from the still at those strengths.	In the case of weak liquors of 78° U. P. and 80° U. P., the consumers prefer freshly made spirit. But the general practice here is that the liquor manufac*tured in a day is passed out to* retail shops on the following day. Thus the liquor is not kept in store, in the distillery, for more than a day. There is no rule governing the matter.

Name of distillery.	Distance from Railway Station.	Number of stills.	Class of stills used.	Approximate cepacity.	Material used.	Proportion of materials in every maund.	Process or processes employed.	The period for which the wash is left fermenting.		Time allowed to elapse between the completion of fermentation and distillation.	Average strength (in terms of proof spirit) of the spirit taken from the receivers.	The period for which freshly-made spirit is kept in store. Rules governing this matter.
								In the hot season.	In the cold season.			
Arrah (Shahabad).	2 miles from the Arrah Railway Station.	4 pot-stil's and 1 Rassa pattern still.	All the stills are made of copper and are heated by coal fire. All the stills have got condensing coils or worms made of copper and refrigerator. The Rassa pattern still has got goose neck and the mouths of the still are narrow. The stills are loaded with the wash and are heated by direct contact with fire.	(1) Rassa pattern = 260 gallons. (2) Pot-still = 102 gallons. (3) Pot-still = 103 gallons. (4) Pot-still = 85 gallons. (5) Pot-still = 87 gallons.	Here mohwa flowers and gur (cane sugar) are used as materials for distilling liquor. During the mangoe season the juice of mangoe is mixed with gur for distilling liquor. Sometimes bael fruits and jack fruits and blackherrie (jamun) are also added to the vats containing gur. Besides the above active wash, spent wash and water are also added.	In case of pure gur the materials are used in the following proportions :— 1 maund of gur, 2 gallons of active wash, 8 gallons of spent wash, and 20 to 26 gallons of water, according to the capacity of the fermenting vessel. In case of mohwa, the materials are used in the following proportions :— 35 seers of mohwa, 5 seers of gur, 2 gallons of active wash, 8 gallons of spent wash, and 20 to 26 gallons of water according to the capacity of the fermenting vessel. When fruits are added, instead of a maund of gur only 35 seers of gur are allowed, but the same quantity of water, spent wash and active wash is used.	In case of mohwa, on the first day of loading a fermenting vessel, only 2 gallons of active wash , 8 gallons of spent wash, 5 seers of gur, and 12 gallons of water are put together ; on the next day 35 seers of mohwa and the required quantity of water are added. In case of pure gur, on the first day 1 maund of gur, 2 gallons of active wash, 8 gallons of spent wash, and 12 gallons of water are put into the vat. On the next day only the required quantity of water is added. When the fermentation is complete, the wash is taken out for loading the stills ; the still is heated by direct contact with fire. The alcoholic vapour which comes out is condensed and collected in the receivers. The liquor is then tested and blended with water or liquor of lower strength in order to bring it to the fixed strength.	Mohwa = 3 or 4 days. Gur = 9 or 10 days	Mohwa = 6 or 7 days. Gur = 13 to 15 days	Generally about 6 or 7 hours. It does not exceed 12 hours.	Average strength of the spirit taken from the receivers— In case of 87° U. P. = 64° U. P. In case of 65° U. P. = 63° U. P. In case of 45° U. P. = 43° U. P. In case of 5° U. P. = 4° U. P. Here liquor of above mentioned strengths is issued.	As the sale of liquor of 87° U.P. is the largest here, the greater portion of this liquor distilled in a day is issued on the same day. If this liquor is kept for more than 3 or 4 days its taste becomes acid. The quantity required in a day is distilled daily ; a very small quantity is therefore left in the store room. The other kinds of liquor are generally kept in store for some time before issue. There is no rule governing this matter, but the consumers here generally prefer fresh spirit.
Chapra (Saran.)	One mile from the Chapra Railway Station.	5	They are large goose-neck copper retorts heated by coal, the condensing apparatus being a spiral copper tube (called the worm) immersed in water over which a continuous flow of cold water is maintained. The receivers are wooden casks fitted in masonry reservoirs.	Capacities varying from 133 to 230 gallons.	Mohwa and gur, sometimes aniseed, cardamom and other spices are used for flavouring. Sometimes gur only is used.	Mohwa = 30 seers. Gur = 10 seers. (To every maund of material 10 gallons of spent wash, 22 gallons of water and ½ gallon of active wash were added.)	On the first day 5 seers of gur, about 5 to 6 gallons of spent-wash and about the same quantity of water and ½ gallon of active wash are put in each vat. Next day the mohwa is added and the required quantity of water is put in. The mixture is stirred twice a day and a small quantity of water is sprinkled over every time it is stirred. When fermentation is complete the wort is put into the copper-stills which are heated by coal. The vapour condenses in passing through the worm and the condensed vapour collects into the wooden receiver through a delivery pipe connecting it with the worm.	4 or 5 days.	5 to 7 days.	There is hardly any interval between the completion of fermentation and distillation.	Liquor of three fixed strengths is issued here, *viz.*, 85° U. P., 50° U. P., and 25° U. P. For the weakest liquor the average strength of the spirit in the receiver is 63° U. P. or 37 per cent. proof-spirit, for the 50° U. P. it is 40° U. P. or 60 per cent. proof-spirit. for the 25° U. P. it is 20° U. P. or 80 per cent. proof-spirit.	The liquor distilled is generally issued on the same day. There is no rule governing the matter.
Betteah (Champaran).	One mile from the Bettiah Railway tation.	3	Narrow-mouthed copper-still.	1 of 70½ gallons. 2 of 108 gallons each.	Mohwa and gur (cane).	30 seers of mohwa and 10 seers gur in a maund.	The fermenting jars are kept buried up to neck under earth They are rubbed with straw and well washed with cold water each time before they are loaded. On the first day water, spent-wash and gur are put in the vats in the morning. After 3 or 4 hours about a quarter-gallon of active-wash from an already fermenting vat is added to it to set in fermentation ; this mixture is then thoroughly stirred and it begins to ferment in a short time. It is allowed to continue in this state till next morning when mohwa is added to it. In the afternoon of the second day the whole mixture or wash is stirred to accelerate fermentation which is allowed to go on till the evening or night of the third day. Stirring goes on once every day till the fermentation is complete. On the morning of the fourth day the completely fermented wash is removed to the still for distillation. The mouths of the loaded jars are not closed. *Constituents of wash.* 15 seers mohwa. 5 „ gur. 6 gallons spent-wash. 14 „ water. ¼ gallon active wash.	3 days.	5 or 6 days.	8 or 9 hours.	73° or 74° U. P.	A large quantity of the spirit is generally taken away the very day it is distilled and the balance is kept in store for 2 or 3 days only. There is no rule governing the matter.
Muzaffarpur	Within a mile from the Muzaffarpur Railway station.	6	5 are copper stills generally known as country pattern stills and 1 Rassa pattern still.	Capacity of 5 pot-stills varies from 70 to 136 gallons and that of Rassa pattern is 272 gallons.	Mohwa and gur.	Proportion of gur to mohwa is 1 to 3. Every maund of mixed materials consists of 10 seers of gur and 30 seers of mohwa.	On the first day 10 seers of gur (molasses) are mixed with the spent-wash and water and loaded in a fermenting vessel. On the following day 30 seers of mohwa are put in the same vessel and allowed to ferment. Twenty-four gallons of water, 16 gallons of spent-wash and 1 gallon of active wash are mixed with every maund of mixed materials (mohwa and gur.	4 to 5 days.	6 to 7 days.	No time is allowed.	60·9° U. P.	When the demand for liquor is great, the freshly-made spirit is issued for retail sale. But when the demand is small it is kept for sometime in the store room of the distillery. There is no fixed rule governing this matter.

Name of distillery.	Distance from Railway Station.	Number of stills.	Class of stills used.	Approximate capacity.	Materials used.	Proportion of materials in every maund.	Process or processes employed.	The period for which the wash is left fermenting—		Time allowed to elapse between the completion of fermentation and distillation.	Average strength (in terms of proof-spirit) of the spirit taken from the receivers.	The period for which freshly-made spirit is kept in store. Rules governing this matter.
								In the hot season.	In the cold season.			
acca ...	A mile from the Dacca Railway station.	6	Fire-heated Rassa pattern stills with goose-necks.	Average capacity varies from 200 to 216 gallons.	Gur.	Gur (to every maund of gur 18 gallons of spent-wash and 18 gallons of water are added).	Earthen jars (vats) are used here as fermenting vessels. These jars, before being filled with the wort, are first cleansed, then exposed to the sun, and at last fumigated and dried after which spent-wash is put into them; and then ⅔rds of the required water is put, the remaining quantity of water being kept for dissolving gur. Four maunds of gur are then mixed with 24 gallons of water and are stirred in a tub so long as the whole quantity of gur is not dissolved properly. After this is done, the quantity of solution is equally put into the jars. The wash in the jars is stirred twice daily till the fermentation commences and afterwards once a day till it is completed. Generally the fermentation begins on the third day here and some time on second day. And when the fermentation is complete, which is ascertained by testing the wort by the saccharometer, the wash is distilled. The experience of both the *bhatwans* and distillery officers is also made use of.	Cane gur, 19 days Date „ *Nil.*	Cane gur, 21 days. Date „ 12 „	Not more than three days at the latest; but generally on the following day after the fermentation ceases.	Strength varies from 9° to 45° U. P. (figures from July to September 1904 taken) and the average strength is 24·6° U. P.	Freshly-made liquor is always kept in store for any length of time and is issued when required. It is seldom issued before being stored into the godown. There is no fixed rule governing this matter.
aridpur ...	Less than a mile from the Faridpur Railway station, Eastern Bengal State Railway.	7	Faridpur pattern, *i.e.*, pot-stills with goose-neck and condensed and pot-still.	Average capacity varies from 47 to 68 gallons.	Date and cane molasses.	Date and cane molasses (14 gallons of spent-wash and 14 gallons of water are added to 30 seers of date or cane molasses).	The fermenting jars are carefully washed with hot water and dried in the sun preliminary to their being fumigated on the previous day on which they are loaded. Thirty seers of date or cane molasses are then thoroughly dissolved in water in a wooden vessel from which the solution is carried into the fermenting jars in which 14 gallons of spent-wash and 14 gallons of water (including the quantity in dissolving the molasses used) are put and the solution is stirred for some time. In the evening of the same day, or on the following day at the latest, about ¼th of a gallon of actively fermented wash is added to the solution to set up fermentation. Accacia bark and sediment deposited at the bottom of jars in which wash has been successfully fermented are also used for setting up fermentation. Generally after 6 to 12 days fermentation is completed and wash is removed to the still for distillation. At the commencement of the work a preparation, popularly known as *metha*, is made of flat rice (chira) and the hakhar in the following process:—About one seer of this flat rice is soaked in sufficient quantity of water that may make it soft, and 80 balls of bakhar are reduced into powder and added to and thoroughly mixed with this soaked flat rice which is then kept in a new small earthen vessel for three days after which it is added to the fermenting jar loaded in this case with the solution of 30 seers of date or cane molasses and 4 gallons of spent-wash and 20 to 24 gallons of water. This process is repeated twice or thrice in a year, *i.e.*, when the speot-wash becomes weak.	9 days.	12 days.	No time is allowed to elapse between the completion of fermentation and distillation. Only in verey rare cases, when the workmen become ill, only a day's time is allowed.	30° U. P.	Freshly-made spirit is not purposely kept back in the store any longer than what the demand of such spirit allows. Sometimes on special occasions the liquor remains in the godown for 2 months, and rarely 3 to 4 months. There is no rule governing the matter.
arisal (Backergunge).	80 miles from Khulna.	5	Fire-heated pot-stills.	I.—107 gallons. II.—66½ „ III.—98 „ IV.—64 „ V.—60 „	(i) Chitta gur. (ii) Mohwa.	(i) Chitta gur, 1 maund (ii) Mohwa ½ „ (iii) Chitta gur ½ „ (To every maund of materials are added 12 gallons of spent-wash, 18 gallons of water and ¼ gallon of active-wash.)	The vat is cleaned with hot water; after this the inside is fumigated. The required quantity of water is then put into the vat and then the gur. The whole thing is then thoroughly smashed, and when the gur has completely dissolved in water, the required quantity of luke-warm spent-wash always below 94° Farenheit is added to it. The wash is stirred again and the whole thing is left undisturbed for the day. On the evening of the second day ¼ of a gallon of active-wash from another vat is added to the wash and it is stirred. The stirring continues every day once for 8 or 9 days and then at intervals. When it is nearly ready for distillation it is left undisturbed. The mouth of the vat is kept open till the attenuation, and then when it is declining, the mouth of the vat is closed. In the case of mohwa it is put into the vat in the morning and left to soak in the water for the day. In the evening the required quantity of gur is added. It is thoroughly stirred, as in the case of gur. When the gur has completely dissolved in the water and the mohwa also partly broken, spent-wash is added. The process of stirring then continues as stated before. Bakhar is sometimes used in the place of active-wash and sometimes after it, when it is seen that the spent-wash and the active-wash have failed to set up proper fermentation. Bakhar is introduced into the wash in the shape of a ball and allowed to float over it for a day or two and then in the process of stirring it gradually mixes up with the wash. The scenting matters are first very loosely tied in a piece of cloth and then placed with the receiver at the beginning of distillation	12 to 20 days.	15 to 26 days.	The wash is stilled within 24 hours after the fermentation ceases.	23° U. P.	There is no hard-and-fast rule here regarding the period for which freshly-made spirit is kept in store. Generally spirit made in this distillery is issued within one month of its manufacture.

Name of distillery.	Distance from Railway Station.	Number of stills.	Class of stills used.	Approximate capacity.	Materials used.	Proportion of materials in every maund.	Process or processes employed.	The period for which the wash is left fermenting.		Time allowed to elapse between the completion of fermentation and distillation.	Average strength (in terms of proof-spirit) of the spirit taken from the receivers.	The period for which freshly-made spirit is kept in store. Rules governing this matter.
								In the hot season.	In the cold season.			
...	Six miles from Calcutta	32	Goose-neck stills. Fire-heated. The still is made of copper and is cylindrical in size. There is a plate inside, just below the capital of the still, which forms a sort of chamber with the capital in which the vapour is diffused. There is continuous water-supply on the head of the still. This mechanism serves the purpose of an imperfect rectifier. A condensing tank with block-tin worms on it is fitted to the vapour conduct-pipe of the still.	About 500 galloos each.	Chitta gor (date treacle), Dhima gur (hard cane molasses), and mohwa.	Ordinarily the following is the proportion:— Chitta gur, 39 seers. Dhima gur, 1 seer. In case when mohwa liquor is manufactured, the following is the proportion of the materials used:— Mohwa, 20 seers. Chitta gur, 19 „ Dhima gur, 1 seer. (To each maund of materials 16 gallons of water and 4 gallons of spent-wash are added.)	Earthen jars are used as fermenting vessels. They are placed in an inclined position and partly buried under ground. These jars are first washed with water and with a brush composed of fine bamboo sticks. They are then fumigated by burning straw inside, and allowed to cool. Water and soent-wash are then put into the vessels and materials added. The whole thing is stirred and mixed together. Generally on the third day the mouths of those loaded jars are closed and kept in this state till the wash is removed to the still for distillation.	The wash is left fermenting for 5 to 6 days.	Generally the time required is 7 to 9 days.	The wash is distilled as soon as it is ripe.	88° P. C. L. P. on an average, *i.e.*, 12° U. P.	There is no restriction in the matter, and there is no specified rule governing the matter. Here the tendency is generally to clear the liquor as soon as it is produced as the consumers prefer freshly-made spirit.
(Nadia)	Ooe mile from the Krishnagore Railway statioo, Raoaghat-Krishnagore Ligbt Railway.	2	Rassa-pattern copper stills with coiled pipe (block-tin); tbey are fire-beated.	1 of 262 gallons. 1 of 237 „	Date gur.	Date gur. (To every maund of gur 6 gallons ol spent-wash and 18 gallons of water are added.)	Spent-wash is put into the vats on the first day; on the second day water is added, and on the third day gur is added.	7 to 10 days:	10 to 14 days.	About 12 hours.	30° U. P.	Liquor in store is not allowed to become older than a month. There is no rule governing the matter.
...ampur	13 miles from Azimgunge Railway statioo, East Indian Railway loop-line *viâ* Nalbati.	4	Pot-stills, fire-heated; copper-made, narrow-mouthed still witb a capital or still bead of the same metal.	1 of 104 gallons. 1 of 156 „ 1 of 180 „ 1 of 56 „	*Rab* or soft cane gur, choa or molasses from cane gar, date gur, soft molasses from date gur.	*Rab* or choa by itself, or both mixed io equal proportion. Date gur with date molasses or cane molasses in equal proportion.	Earthen jars from 17 to 24 gallons liquid capacity in which gur is imported are used as fermenting jars. Each time before being loaded these jars are washed clean and subjected to fumigation. Materials, together with water and a quantity of spent-wash from the still of a previous distillation, are then put in, in the proportion of 3¼ to 3¾ quarts liquid to a seer of material. The material being thoroughly dissolved, a quantity (about half a gallon) of wash from a jar under active fermentation is added which induces fermentation in few hours and the contents continue to be stirred once every day for three or four days successively in summer, and about double the number of days in winter.	7 to 12 days.	14 to 20 days.	Wash of which the fermentation is completed at a time when it is not possible to distill it on the same day and wash becoming fit for distillation in course of the night are worked off on the following day. But when n Sunday intervenes and the wash is ready for distillation and when more vats fit for emptying than can be worked off in a day become ripe at a time, the distillation is put off for the next day.	71 per cent. proof-spirit, including re-distillation; 77 per cent. proof-spirit, excluding re-distillation.	The average age of liquor in store is about 15 days, but when the stock has to be increased for meeting the demand for particular occasions, such as Doorga Poojah, Holi festival, the liquor may remain for a month in store. At present there is no rule on the subject.
...	1 mile from the Jessore Railway station, Bengal Ceotral Railway.	4	Pot stills (fire-heated).	Capacities varying from 61 to 77 gallons.	Gur.	Gur (12 gallons of water and 12 gallons of spent-wash are added to one maund of gur.)	The water, spent-wash and gur are mixed and then the mixture is stirred with the hand or stick and left in the vat.	15 to 20 days.	15 to 20 days.	In certaio cases only one day.	30° U. P.	No hard-and-fast rule is observed here governing this matter. Both new and old liquor are issued according to demand and convenience.
...	1 mile from the Khulna Railway station, Bengal Central Railway.	1	Fire-heated still of Rassa pattern with a block-tin worm.	150 gallons.	Date gur.	Date gur (9 gallons of spent-wash, 15 gallons of water and ½ gallon of active wash are added to one maund of date gur.)	As soon as the wash is completely fermented, it is put into the still, and after three hours firing, distillation commences. A little before the commencement of distillation a receiver (wooden cask) is placed just below the conduct-pipe, and a lantern through which the liquor passes into the receiver is posted into the bung-hole. The receiver and the lantern are fastened together with an iron chain and locked up by a Chubb's lock. When the conduct-pipe becomes hot and liquor appears to pass, a continuous flow of cold water is allowed to fall over the still head as well as on the refrigerator by means of two branch pipes from the main water-pipe. The distillation is finished after four hours from the time distillation commences. Liquor is then carried into the godown where it is measured and tested.	7 to 10 days.	10 to 15 days.	12 hours' time is generally allowed.	About 25° U. P.	Liquor is kept in the store room after distillation. It is allowed to remain there from 10 to 25 days. Generally a month's requirements are kept in stock. There is no rule governing the matter.

Name of distillery.	Distance from Railway Station.	Number of stills.	Class of stills used.	Approximate capacity.	Materials used.	Proportion of materials in every maund.	Process or processes employed.	The period for which the wash is left fermenting.		Time allowed to elapse between the completion of fermentation and distillation.	Average strength (in terms of proof-spirit) of the spirit taken from the receivers.	The period for which freshly-made spirit is kept in store. Rules governing this matter.
								In the hot season.	In the cold season.			
Burdwan ...	2 miles from the Burdwan Railway Station, East Indian Railway.	5	Fire-heated Rassa pattern stills.	1 of 500 gallons. 2 of 400 „ 2 of 300 „	Gur of different descriptions such as date gur, cane gur and chitta and mohwa flowers.	In the case of mixed materials $\frac{3}{4}$ths maund of mohwa and $\frac{1}{4}$th maund of chitta. In the case of gur alone $\frac{5}{6}$th maund of chitta and $\frac{1}{6}$th maund of gur.	In case of mixed material (mohwa and chitta) from which mohwa liquor is produced, on the first day the following materials are put in a vat:— ½ gallon of active wash, *i.e.*, wash from the vat already fermenting. 12½ gallons of water. 12½ gallons of spent-wash or wash from which liquor has been extracted. 7½ seers of chitta. On the second day the loading is made full by adding 22½ seers of mohwa. In the case of gur liquor on the first day:— ½ galloo of active-wash. 12½ gallons of water. 12½ gallons of spent-wash. 5 seers of gur. Oo the second day the full load of 25 seers of chitta is added.	5 or 6 days.	6 or 7 days.	No time is allowed to elapse. The wash is distilled as soon as the fermentation is complete.	32° U.P. or 68° in term of proof spirit.	1 to 15 days generally. In emergent cases fresh spirit is occasionally issued. There are no rules governing the matter.
Suri (Bir-bhum).	12 miles from the Santhia Railway station, East Iodian Railway (Loop Line).	4	Country pattern still ...	1 of 130 galloos. 1 of 96 „ 1 of 82 „ 1 of 80 „	Ordinarily mohwa is used for the manufacture of liquor. When good mohwa is not available, gur is added with mohwa.	(1) Mohwa, 40 seers. (2) Mohwa, 32 „ Gur, 8 „	(1) Mohwa, 40 seers. Spent-wash, 16 gallons. Water, 24 „ Active-wash, 1 gallon. (2) Mohwa, 32 seers. Gur, 8 „ Spent-wash, 16 gallons. Water, 24 „ Active-wash, 1 gallon. All mixed together, but the active-wash is put into the vats some time after to allow the sugar to dissolve thoroughly. The active-wash is taken from jars, which are in active fermentation. Before the materials are put in, the vats are properly cleaned and are subjected to fumigation to kill the germs that might exist in the vats, and after the vats are loaded the wash is left to what is called spontaneous fermentation. When the fermentation is complete the wash is put into the still and distilled. The still is heated with fire at the bottom and a continuous flow of water passes over the still-head from the time distillation begins and until it is finished.	In case of mohwa 5 days. In case of mixed materials 7 day:	In case of mohwa 6 or 8 days. In case of mixed materials 8 to 12 days.	When the fermentation is complete no time is lost in distilling the wash. If the wash has become completely fermented in the evening, it is distilled on the following morning, and when there are two distillations after the first distillation is finished, *i.e.*, at about midday.	The average strength of the spirit taken from the receivers at first distillation is 51° U. P. To obtain strong liquor the liquor obtained by first distillation is also redistilled. Aniseed, plantain, and other materials are sometimes put into tho still at the time of redistillation for flavouring the liquor.	Up to the time of issue which might be on the following day or sometimes days or months after. It is kept in store sometimes for a month or two and even for a longer period. There is no rule.
ankura ...	2 miles from the Bankura Railway station, Bengal-Nagpur Railway.	4	Country pattern stills, that is narrow mouthed pot-stills of metal heated by fire.	1 of 45½ gallons. 1 of 51 „ 1 of 60¾ „ 1 of 68 „	Mohwa is the only material used.	Mohwa.	One maund ten seers of mohwa is mixed with 3 gallons of water and then put into the vats, and when the fermentation ceases completely the wash is distilled.	4 to 6 days.	6 to 10 days.	No time allowed.	14° U. P.	No liquor is issued to the retail shops for sale on the very day it is distilled, but it is kept in store along with that previously manufactured and stored. It is issued on retail passes, There are no rules governing this matter.
idnapur ...	One mile from the Midnapur Railway station, Bengal-Nagpur Railway.	6	Pot-stills (copper made) fire-heated.	The capacity of the stills varies from 60 to 88 gallons, the average being 78 gallons.	Mohwa.	Mohwa.	The wash is prepared in wooden vats open at the top. Thirty seers of mohwa are put into each vat with 28 gallons of water and two gallons of the purest* ferment. The purest ferment is added only to accelerate fermentation. The whole thing is stirred and then left to ferment. * Purest ferment consists of— 1 seer of molasses. 1 seer of water with a small quantity of active-wash (*i.e.*, a handful of wash taken from a vat the contents of which is ready for distillation).	4 to 7 days.	7 to 12 days.	The wash is distilled as soon as the fermentation is completed.	Weak:— 50° U.P. for issue. *60 U. P. for redistillation.* Strong:— 10° U.P. for issue after redistillation.	If there is sufficient stock in the liquor godown freshly-made spirit is usually kept in store for nearly two months before issue. *There is no fixed rule governing the matter.*

UNITED PROVINCES.

No. 354—XIII—875-A., dated Naini Tal, the 15th October 1904.

From—J. M. **Holms**, Esq., I.C.S., Secretary to Government, United Provinces,

To—The Secretary to the Government of India, Finance and Commerce Department.

In compliance with the request contained in Mr. Campbell's letter, No. 5474-S. R., dated the 30th August 1904, I am directed to submit, for the information of the Government of India, a note prepared by the Commissioner of Excise, United Provinces, which contains information for each distillery in this province regarding the points mentioned in the memorandum appended to the letter of the Government of India under reply.

2. With reference to the Rosa distillery at Shahjahanpur, which is worked according to European methods, I am to say that the Commissioner of Excise is unable to state the proportions of the materials used.

3. The distilleries which Major Bedford could most profitably visit are those situated in the districts of Allahabad, Cawnpore, Lucknow and Shahjahanpur (the Rosa distillery). An outstill in the Allahabad district might also be inspected.

UNITED RROVINCES.

Saharanpur District.

I. Name of distillery—Saharanpur.

II. Class of still used—Pot still : fuel, wood.

III. Materials—(*a*) Shira, spent wash and water in proportion 45 : 30 : 20.

IV. Process—Double distillation generally : sometimes single in cold weather.

V and VI.—See general description.

VII. Strength of distillate—50° U.P. first distillation : 25° U.P. second distillation.

VIII. See general description.

Dehra District.

I. Name of distillery—Dehra Dun.

II. Class of still used—Pot-still : fuel, wood.

III. Materials—Shira, spent wash, water in proportion 60 : 60 : 70.

IV. Process—Partial double distillation.

V and VI. See general description.

VII. 50° U.P. first distillation : 25° U.P. second.

VIII. See general description.

Meerut District.

I. Name of distillery—Meerut.

II. Class of still used—Pot-still : fuel, wood.

III. Materials—Shira, {Ferment of spent wash and shira} and water in proportion.
120 : 96 : 130.

IV. Process—Partial double distillation.

V and VI. See general description.

VII. Strength of distillate—50 to 75 U. P. first distillation : 25 U. P. second distillation.

VIII. See general description.

Mainpuri District.

I. Name of distillery—Mainpuri.

II. Class of still used—Pot-still : fuel, cowdung.

III. Materials—Mhowra or shira, water and spent wash in proportion
50 : 60 : 33⅓ to 27 : 6½ to 13.

IV. Process—Partial double distillation.

V and VI. See general description.

VII. Strength—50 or 60° U.P. first distillation : Proof or 25° U.P. second distillation.

VIII. See general description.

Bareilly District.

I. Name of distillery—Bareilly.

II. Class of still used—Pot-still : fuel, wood.

III. Materials—Shira, water and spent wash in proportion.
100 : 90 : 90.

IV. Process—Partial double distillation.

V and VI. See general description.

VII. Strength of distillate, 50° U.P. first distillation : 21 to 26° U.P. second distillation.

VIII. See general description.

Moradabad District.

I. Name of distillery—Moradabad.

II. Class of still used—Pot still : fuel, cowdung and little wood.

III. Materials—Shira, water and spent wash in proportion.
60 : 120 : 120.

IV. Process—Partial double distillation.

V and VI. See general description.

VII. Strength of distillate—50° U.P. first distillation : 25° U.P. second distillation.

VIII. See general description.

Shahjahanpur District.

I. Name of distillery—Shahjahanpur.

II. Class of still used—Pot-still : fuel, wood.

III. Materials—Shira, water and pent wash.

IV. Process—Partial double distillation.

V and VI. See general description.

VII. Strengh of distillate—50° U.P. first distillation : 25° U.P. second distillation.

VIII. See general description.

Cawnpore District.

I. Name of distillery—Cawnpore.

II. Class of still used—Pot-still and one Bombay still.

III. Materials.—Mahwa, water, spent wash, ferment and babul bark (Jeta) 40 : 110 : 35 or 40 : 5-6 in proportion.

IV. Process—Single and partial double distillation.

V. and VI. See general description.

VII. Strength of distillate—50° U. P. first distillation : 25° U. P. second distillation : 25° U. P. first distillation in cold weather.

VIII. See general description.

Allahabad District.

I. Name of distillery—Rasulabad.

II. Class of still used—Pot-still : fuel, wood.

III. Materials—Mahwa, shira, water and spent wash in proportion.
80 : 20 : 190 : 70.

IV. Process—Partial double distillation.

V. and VI. See general description.

VII. Strength of distillate—50° U. P. first distillation : 25° U. P. second distillation.

VIII. See general description.

Benares District.

I. Name of distillery—Benares.

II. Class of still used—Pot-still : fuel, wood.

III. Materials—Mahwa, shira, { Shira, ferment, water, spent wash.
or
40 : 20 { 10 : 10 : 90 : 125.

IV. Process—Single distillation : low wines sometimes added.

V and VI. See general description.

VII. Strength of distillate—17 to 18° U. P.

VIII. See general description.

Mirzapur District.

I. Name of distillery—Mirzapur.

II. Class of still used—Pot-still : fuel, wood.

III. Materials—Mahwa, shira, water and spent wash in proportion.
48 : 26 : 70 : 60.

IV. Process—Single distillation.

V and VI. See general distillation.

VII. Strength of distillate—17 to 20° U. P. hot weather : 8 to 12° U. P. cold weather.

VIII. See general description.

Jaunpur District.

I. Name of distillery—Jaunpur.

II. Class of still used—Pot-still : fuel, wood and cowdung.

III. Materials—Mahwa, shira, water, spent wash and a little ferment.
19 : 43 : 90 : 100 : in proportion.
IV. Process—Single distillation.
V and VI. See general description.
VII. Strength of distillate—25° U. P.
VIII. See general description.

Ghazipur District.

I. Name of distillery—Ghazipur.
II. Class of still used—Pot-still : fuel, cowdung.
III. Materials—Mahwa, shira, water and spent wash.
IV. Process—Single distillation.
V and VI. See general description.
VII. Strength of distillate—25° U. P.
VIII. See general description.

Gorakhpur District.

I. Name of distillery—Gorakhpur.
II. Class of still used—Pot-still : fuel, wood.
III. Materials—Mahwa, shira, water and spent wash.
8¾ : 43¾ : 40 : 40.
IV. Process—Single distillation.
V and VI. See general description.
VII. Strength of distillate—25° U. P.
VII. See general description.

Lucknow District.

I. Name of distillery—Lucknow.
II. Class of still used—Pot-still and Bombay still : fuel, wood.
III. Materials—Mahwa, water and spent wash.
55½ : 225 : 112½.
Bombay still 200 : 660 : 420 and ferment (Khamir) 15 in proportion.
IV. Process—Partial double distillation.
V and VI. See general description.
VII. Strength of distillate—50° U. P. first distillation : 23 to 27° U. P. second distillation.
Bombay still—60 to 70° U. P. in hot and 50 to 60 U. P. in cold weather. Redistilled in the pot-still yields—20 to 25° U. P.
VIII. See general description.

Unao District.

I. Name of distillery—Unao.
II. Class of still used—Pot-still : fuel, cowdung.
III. Materials—Mahwa, water, spent wash and ferment in proportion.
40 : 70 : 20 : 5·6.
IV. Process—Single distillation and partial double distillation.

V and VI. See general description.

VII. Strength of distillate—50° U. P. first distillation ; 25° U. P. second distillation.

VIII. See general description.

Rae Bareli District.

I. Name of distillery—Rae Bareli.

II. Class of still used—Pot-still : fuel, wood.

III. Materials—Mahwa, and water in hot, or in cold weather water and spent wash in varying proportion.
40 to 50 : 250.

IV. Process—Partial double distillation.

V and VI. See general description.

VII. Strength of distillate—40 to 50° U. P. first distillation : 15 to 25° U. P. second distillation.

VIII. See general description.

Sitapur District.

I. Name of distillery—Sitapur.

II. Class of still used—Pot-still : fuel, wood.

III. Materials—Shira, water and spent wash in hot weather. In cold
72 : 120 : 94 weather proportions revised.

IV. Process—Single distillation.

V and VI. See general description.

VII. Strength of distillate—16 to 30° U. P.

VIII. See general description.

Fyzabad District.

I. Name of distillery—Fyzabad.

II. Class of still used—Pot-still : fuel, kaseri grass.

III. Materials—Mahwa, Shira, water, spent wash and ferment (Jeta)
50 : 50 : 100 : 70 : 4 or 5
in proportion.

IV. Process—Single distillation.

V and VI See general description.

VII. Strength of distillate—25° U. P.

VIII. See general description.

Gonda District.

I. Name of distillery—Gonda.

II. Class of still used—Pot-still : fuel, wood and *jhao* stalks.

III. Materials—Mahwa, water, spent wash and ferment and babul bark.
34 : 110 : 10
in proportion.

IV. Process—Single distillation.

V and VI. See general description.

VII. Strength of distillate 25° U. P.

VIII. See general description.

Bahraich District.

I. Name of distillery—Bahraich.

II. Class of still used—Pot-still: fuel, wood.

III. Materials—Mahwa, water and ferment in proportion.
50 : 120 : 1

IV. Process—Single distillation.

V aud VI. See general description.

VII. Strength of distillate—20 to 26° U. P.

VIII. See general description.

Sultanpur District.

I. Name of distillery—Sultanpur.

II. Class of still used—Pot-still : fuel, wood and cowdung.

III. Materials—Mahwa, shira, water and spent wash in proportion.
72 : 12 : 250 : 100.

IV. Process—Partial double distillation.

V and VI. See general description.

VII. Strength of distillate—40 to 50° U. P. first distillation: 18 to 28° U. P. second distillation.

VIII. See general description.

Partabgarh District.

I. Name of distillery—Kunda.

II. Class of still used—Pot still : fuel, wood and cowdung.

III. Materials—Mahwa, shira, water and spent wash in proportion.
100 : 5 : 120 : 180.

IV. Process—Partial double distillation.

V and VI. See general description.

VII. Strength of distillate—50 to 60° U. P. first distillation : 25° U. P. second distillation.

VIII. See general description.

GENERAL DESCRIPTION OF THE NATIVE PROCESSES OF SPIRIT MANUFACTURE IN THE UNITED PROVINCES.

The ordinary pattern of still in use is the pot-still. The still proper is copper of this shape (in section).

The capacity varies from 20 to 50 gallons. The head is of earthenware, and is simply an inverted open mouthed vessel connected with the receiver by a bamboo pipe. The joint between the head and still body is closed with clay, the charging of the still, and the removal of the spent wash is effected by removing the head and its attachments. As a general rule, there is no worm fitted : the 'lye pipe' discharges direct into the receivers which are kept closed and immersed in water during the whole operation. The still is heated by an open furnace: chimneys are sometimes fitted, but no attempt is made to regulate the heat by dampers.

In one or two distilleries a roughly made worm, immersed in a tank, is used, and the spirit drawn off continuously outside the tank by means of an open pipe. Another variation in use in two distilleries is to make the receiver with double walls, the cavity being connected with a pipe which discharges the spirit outside the condensing tank. Occasionally two lye-pipes and receivers are connected to one still.

Stills of the 'Bombay' pattern are in use in the Lucknow and Cawnpore distilleries. They are of much larger capacity (100 to 300 gallons): have properly constructed worms immersed in tubs, and a separate discharge cock or valve for the spent wash. The pattern is much the same as the ordinary pot-still of Europe, except that the 'head' is of wood and is removable for charging purposes.

As regards processes, the local variations are considerable, but the essentials are the same. The raw materials are mahua and shira and occasionally gur. In the eastern districts mahua alone, or mahua and shira mixed are used : in the western districts, shira alone. Roughly speaking, all districts to the west of a line drawn from Bahraich to Mainpuri used shira only. The raw material is 'set up' with varying proportions of spent wash and water. Fermentation sets in either spontaneously, or after the addition of a small quantity of 'live' wash. No prepared yeast is used. The proportion of spent wash added is generally less in the hot weather. The wash is fermented either in earthen pots, or in casks. Pots are sometimes buried in the ground. The best outturn is obtained from unburied pots. Stone vats are used in one or two distilleries.

Fermentation is complete in three to five days in the hot weather. In the cold weather it takes longer—sometimes as many as nine days; completion is judged by the cessation of effervescence and the disappearance of sweetness. If a still is ready, the wash is distilled at once, but owing to the uncertainty as to when fermentation will be complete, and the fact that night or Sunday working is not allowed, 48 hours may elapse before distillation, with the result that acetous fermentation sets in and there is a loss of spirit.

There are three distillation processes in common use. First single distillation. Spirit of the lowest prescribed strength (25° U. P.) is obtained in one operation. This process is practically confined to distilleries using mahua ; secondly the whole of the singly distilled spirit is mixed with fresh wash and redistilled ; this is described as ' partial double distillation ' in the notes on individual distilleries; thirdly, the singly distilled spirit is redistilled without admixture. There is a fourth process occasionally employed. The single distillate is separated into two portions : the first is sent to store, the second mixed with fresh wash and redistilled. Spirit at proof strength can be obtained by redistillation only : the bulk of this spirit is made from shira only. Generally speaking, spirit is issued for consumption within 15 days of its preparation. The maximum age of the spirit ordinarily consumed may be stated as two months. There are no rules on this matter.

Outstills.—The above applies to outstills also, except that the apparatus is of a more rudimentary description, and the strength of the spirit turned out is much weaker.

District Shahjahanpur.

I. Distillery—Rosa, Messrs. Carew and Company.

II. Class of still—Two continuous stills of a continental pattern made in India. The incoming cold wash is used to condensed the spirit coming off the boiling wash. This is effected by means of a rectifying column containing baffle plates, over which the wash slowly trickles, while the steam from the boiling wash below passes up in the contrary direction. The still is steam heats.

III. Materials—shira, spent wash and water. The proportions are unknown.

IV. ' Rum' of any strength up to 20·30° O. P. is obtained at one operation.

V. The distillery works in the cold weather only. Fermentation is expected to be complete in four days.

VI. Distillation takes place at once.

VII. The average strength of the spirit as distilled is unknown.

VIII. The Company advertizes rum at ages varying from six months to twelve years.

It should be added that 'silent' spirit at 40° to 60° O.P. is also manufactured for issue as rectified spirit of wine, or for subsequent denaturing and issue as 'methylated' spirit. This spirit is manufactured in a special non-continuous still of French manufacture fitted with a rectifying column.

PUNJAB.

No. 2367-S., dated Simla, the 5th October 1904.

From—A. B. KETTLEWELL, Esq., Judicial and General Secretary to the Government of the Punjab,

To—The Secretary to the Government of India, Finance and Commerce Department.

In reply to your letter No. 5474-S.R., dated the 30th August, 1904, I am directed to forward a Note by the Excise Commissioner, Punjab, on the working of distilleries in this Province, and to say that the Lieutenant-Governor agrees that it will be sufficient for Major Bedford to visit the Amritsar and Karnal Distilleries.

Note by the Excise Commissioner, Punjab, on Government of India, Revenue and Agricultural Department, letter No. 5474-S. R., dated 30th August 1904.

1. There are no Government Distilleries in the Punjab though outstills exist at—

(1) Firozepur-Jhirka in Gurgaon.

(2) Sultanpur in Kulu.

(3) Hamirpur in Kangra.

The native pot-still fire-heated is employed in all three. Gur and kikar bark are the materials. It appears unnecessary that any of these should be visited by Major Bedford. In 1903-04 the outturn of these three outstills was 196, 1,703 and 2,062 gallons respectively. All are situated at considerable distances from railway stations, and it is the inaccessibility of the localities concerned which had led to the continuance of the system there.

2. In regard to the five private licensed distilleries, particulars as indicated in the questions attached to the Government of India letter, are given in the annexure to this note. The Amritsar Distillery (No. 3) is peculiar in that it has a pair of patent continuous stills, steam-heated. The Karnal Distillery is a good specimen of a concern under native management, with pot-stills which, however improved, are in all essentials similar to those employed by the native distillers in the old Government enclosures. Both Amritsar and Karnal are conveniently situated on the railway: and it is recommended that they be visited by Major Bedford.

H. J. MAYNARD,

Commissioner of Excise, Punjab.

20th September 1904.

LICENSED DISTILLERIES IN THE PUNJAB.

(List of Distilleries).

1. *Karnal.*—" Kundan Lal Kishori Lal and Sons' private Distillery."

2. *Sujanpur.*—" The Punjab Sugar Works and Patent Carbonic Acid Gas Company, Limited," or generally known as " Sujanpur Distillery."

3. *Amritsar.*—" Amritsar Distillery Company."

4. *Rawalpindi.*—" Murree Brewery Company's Distillery, Rawalpindi."

5. *Simla.*—" The Simla New Distillery."

ANSWERS TO QUESTION II.

Karnal.—Two pot and worm-stills. Holding capacity 300 and 500 gallons and distilling capacity 100 and 170 gallons of finished spirit a day, respectively. These are fire-heated stills. Besides these there are two country pot-stills which are heated by fire and are worked on special occasions. They collectively turn out 24 gallons a day.

Sujanpur.—Goose-neck still worked with steam.

There are two steam drums, each containing about 90 copper tubes, 2" in diameter and 1' in length, which serve as heating surface to the wash. The still is composed of one retort, one rectifier and one condensing worm. Its approximate capacity is of about 4,500 gallons of wash, turning out about 300 gallons of spirits L. P. in 24 hours.

Amritsar.—The stills used are (2) two patent continuous steam-heated stills, (2) two fire-heated pots-stills, and (2) two native pot-stills.

The patent stills each turn out on an average 25 gallons of L. P. spirit per hour. One pot-still has a charging capacity of 1,000 gallons of wash and the smaller pot-still has a charging capacity of 30 gallons of wash.

The two native pot-stills have each a charging capacity of 30 gallons of wash.

Rawalpindi.—Pot and worm-stills can be heated either by fire or steam, but fire is generally used. The stills each consists of a 'pot' which slopes up into a narrow 'Swan-neck' to which is attached a 'worm' or coil piping in which the vapour is condensed into a liquid. The capacities of the three stills are 1,000 gallons, 800 gallons and 600 gallons respectively.

Simla.—Two pot stills, fire-heated, one having a charge capacity of 300, and the other of 700 gallons. The larger is used for first distillation (whether of rum or whisky) and the smaller for redistillation. Both have worms or coils.

ANSWERS TO QUESTION III.

Karnal.—(*a*) The following materials are used in preparation of country spirit:—

(1) Molasses (shira), or

(2) Gur (occasionally used), cardamom, saffron, rose sandal and other similar ingredients are sometimes added to the above materials when a flavoured or special liquor is required which is not in general demand.

(*b*) The proportion of the materials used in the preparation of a hundred gallons of ordinary country spirit is given below:—

(1) Molasses	27 maunds (135 gallons) or	alternately.
(2) Gur	25 maunds	
(3) Water	86 maunds (765 gallons).	

Sujanpur.—(*a*) The Manager reports that, as a rule, he uses molasses of 40 B, and during the cane-crushing season the mash is made of molasses, washing of molasses tanks, clarifiers and sugar machines. Gur is very seldom used. Carbonic acid gass is the primary object of this factory and the spirit is a bye-product.

(*b*) When gur is used it is the practice to use two parts of molasses to one part of gur. But generally molasses is employed alone.

Amritsar, (*a*) *and* (*b*).—The materials used in the preparation of the liquor are gur and water mixed in the proportion of 55 gallons of water to one maund of gur.

Rawalpindi, (*a*) *and* (*b*).—Gur only is used and fermented with brewery yeast. The proportion is 55 gallons of water to 1 maund of gur.

Simla, (*a*) *and* (*b*).—For the distillation of whisky, malt prepared from barley is used. For country spirit either gur or khand rab, according to the market. Disinfectants (slaked lime, chloride of lime, carbolic acid and sal ammoniac) are used for the cleaning of tuns, drains, &c., in order to destroy false ferments which would otherwise act on the washers and form acetic or other acids. The materials are not mixed proportionately.

ANSWERS TO QUESTION IV.

	Molases.	*Water.*
1. Wooden cask ...	1½ maunds	4¾ maunds.
or ...	7½ gallons or	42½ gallons.
1. Earthen pot ...	8 seers	25½ seers
or ..	1 gallon or	5⅔ gallons.

Karnal.—Yeast is on the first day (in the evening) prepared for use in the fermenting casks or pots in the following manner. A wooden cask, open at one end, is filled with water, with which nearly 24 gallons of refuse of a previous distillation and some eight seers molasses is mixed and the cask is left alone for the night. Next day molasses and pure water are in the proportion noted in the margin put into the casks or pots, a certain quantity of the yeast being added to each fermenting vessel. The addition of the yeast is intended to cause proper fermentation in the vessels. Watar is put by means of *kalsas* (brass pots) into the vessels. The third day the material contained in these vessels is shaken by hand. All the fermenting vessels are kept under an iron shed or in some kacha or pacca rooms provided in the distillery for the purpose, but they have no lids or covers on them and consequently wasps and other insects fond of sugar sometimes fall* into the fermenting vessels. When the wash is ready for use it is made to run from the fermenting casks to the boiler of still No. 1 through a drain; but in the case of still No. 2, which has no such drain it is taken by hand in *kalsas* to the boiler. When the wash has, thus, been conveyed to the boiler it is covered with a wooden lid around which a piece of cloth mixed with mud is wrapped so as to prevent evaporation of spirit The neck of the still-head is then joined to the " worm " by a brass pipe over which also cloth, &c., is applied as above. The boiler is then heated by means of fire The ' worm " mentioned above is a brass pipe coiled round and round in a wooden condensing vessel kept filled with water. Its end protruding from the condensing vessel discharges the liquid into a receiver which is placed just near it. This receiver is divided into two parts, one for low wines and feints and the other for strong spirit. When the product of first distillation is thus collected in the receiver the still is stopped, the lid (wooden) on the still and the pipe, joining the neck of still-head with the worm, being removed. The refuse of the distillation is then discharged (about 24 out of the 100 gallons being reserved in an adjoining small reservoir for preparing yeast as mentioned in the begining of this paragraph) by a pipe connected with the boiler into a drain which runs through one of the suburbs of the city to a pond. The boiler is then washed or rather cooled for the next distillation by water, taken from the condensing vessel by means of an iron pipe. The condensing vessel, too, is emptied of about ⅛ths of its water, which gets rather hot on account of the first distillation, and fresh water is poured

* The Personal Assistant to Commissioner of Excise at the time of his inspection of his distillery drew the distiller's attention to this defect.

in. The process of the first single distillation ends thus, and this process is repeated twice or thrice (as required by the Distiller) in case of first distillations. When the product of two or three first distillations is accumulated in the receiver the whole lot is put into the boiler by means of *kalsas* for redistillation, the receiver being emptied and the process of covering of the "still-head" and heating by fire, &c. is again adopted as in the case of first distillation, described above. The finished spirit is then discharged by the 'worm end,' and stored just like the product of the first distillation in the receiver, and when the requisite quantity has been obtained the still is made to stop, the finished spirit is removed to store-room under double lock by *kalsas*, the feints being left in the receiver for next day's redistillation and the refuse, &c., being drained away to the pond as stated above.

The hot water discharged from the condensing vessel is drained and accumulated in a large pucca and a kacha reservoir built inside the distillery and is alternately used or put into the fermenting vessels.

None of the brass vessels nor the 'still' and the 'worm' used in the distillery are tinned.

Sujanpur.—The Manager reports that with the raw material as explained above he uses on an average about 500 gallons of hot dunder mixed with about 2,000 gallons of water, till the wash comes to the temperature of 85° Fr. and stands to 71/2 B. If the temperature is lower, he has to use a little more hot dunder and if higher a little more water in order to bring it to the above standard of temperature and density. Afterwards it is well mixed continuously for about 18 hours from the time of setting, till the fermentation starts, then mixing is stopped, and the vat is closed with the patent water pressure joint. The carbonic acid gas (CO_2) generated during fermentation is never allowed to escape in the air, but gathered and subjected to the patent process of removing its vegetable and mineral impurities, and then compressed into solid drawn steel cylinders, and sent out for the aerated water trade. For 24 hours he gathers gas from each vat, when the fermentation is very vigorous but when it becomes weak the generation of gas is so poor that it cannot be collected.

Amritsar.—The gur is put into the hot spirit wash of a previous distillation and allowed to stand for about 16 hours before being washed. After it has been washed it is allowed to cool for about 16 hours, and then water is let on. After the mixture is complete and the specific gravity taken the wash is left to work itself off assisted with rousings of from two to three times a day.

Rawalpindi.—The gur is dissolved in water, the solution consisting of about 55 gallons of water, to one maund of gur. This is fermented and when fermentation is over the fermented liquor is run into the still and the still is kept boiling until all the spirituous vapours have been steamed off. These vapours are condensed into a liquid in the 'worm' of the still and pass as Low wines into the Low Wines Receiver. From the Low Wines Receiver the Low Wines are pumped into the Low Wines Charger which commands the still and are run from this vessel into the still for redistillation. The same process is repeated (in redistillation) as in the case of the distillation of the fermented liquor (or wash), except that in this case care must be taken to separate the pure spirits from the impure on their way from the worm to the various spirit receivers. The 'Feints' (or impure spirit produced in redistillation) are collected in the 'Feints Receiver' and are mixed with the Low Wines for redistillation, and the pure spirit is collected in the spirit receiver and from there it is measured into casks to be bonded.

Simla.—The gur or khand-rab is dissolved in three or four hogsheads of hot water, to which three or four hogsheads of the spent wash of the previous distillation is added. It is kept in a tub for 10 or 12 hours and then pumped up into a cooler, where it remains till its temperature is 70—75° Fr. Two pounds of sal ammoniac is then added to produce fermentanion. After four or five days it becomes fit for distillation. The foreshots and tailings are kept separate (and generally used for making methylated spirits): the rest of the distillate is redistilled, and the product stocked for future issue.

In the case of whisky the barley is kept wet for a few days to enable it to sprout. After a period of germination it is put on kinds and the temperature raised to destroy further germination. Then it is crushed and put into a mash tun containing water at a temperature of about 168° Fr. Then after a few hours the wort goes to another tub called the Wash Receiver, and then cooled on a cooler after which it is passed into the fermenting tuns and fermented till ready for distillation. The process of distillation is the same as in the case of country spirit made from gur or khand-rab.

ANSWERS TO QUESTION V.

Karnal.—(*a*) The mash is left fermenting for four days in the hot, and
(*b*) Five days in the cold season.

Sujanpur.—(*a*) In the hot season from six to seven days, and
(*b*) In the cold from eight to ten days.

Amritsar.—(*a*) and (*b*). The average length of time that wash is left fermenting is from five to six days in the hot season, and six to seven days in the cold season.

Rawalpindi.—(*a*) The time required for fermentation varies with the quality of the gur used, but the average time is about 60 hours in the hot season.

(*b*) Average time about 72 hours in the cold season.

Simla.—(*a*) Three or four days in the hot, and

(*b*) Six or seven days in the cold season.

ANSWERS TO QUESTION VI.

Karnal.—No time is allowed to elapse between the completion of fermentation and distillation. Soon after the completion of fermentation in casks or pots, the wash is put into the boiler for distillation, otherwise it may be spoiled and produce smaller quantity of liquor than it would in the former case.

Sujanpur.—About three days.

Amritsar.—About 12 hours are allowed to elapse between the completion of fermentation and distillation.

Rawalpindi.—Generally about 12 hours.

Simla.—Distillation takes place immediately after the full attenuation has been reached. The interval after fermentation is never more than three days. Otherwise the wash becomes sour and the outturn of spirit is decreased.

ANSWERS TO QUESTION VII.

Karnal.—The average strength (in terms of London Proof) of the spirit taken from the receiver is 98½ degrees.

Sujanpur.—The first distillation produces low wine up to an average strength of 60° U. P. : this is redistilled after sufficient storage of low wines of several first distillations to the highest strength of 40° O. P. and the lowest of 95° U. P.

Amritsar.—The average strength obtained from the receivers is proof.

Rawalpindi.—Average strength of spirit taken from receivers 60 (*sic*) O.P.

Simla.—Including feints and low wines, the average strength is 70° U.P. on first distillation and 30° O. P. on second distillation. But the average strength of spirit taken from receivers to be placed in bond is 30 to 50° O.P.

ANSWERS TO QUESTION VIII.

There are no excise rules governing this matter. The following is the practice in each distillery respectively :—

Karnal.—No freshly made spirit is kept any time before being put on the market. It is ready for issue at any time after it has been prepared and stored in the godown under revenue lock.

Sujanpur.—Spirit is matured from 9 to 12 months before being put on the market. In order to make quick maturing and to save spirit from evaporation, during the hot weather as much as possible, the distiller has a large cooling water tank 31′ x 7′ x 6½′ holding five small vats containing about 3,500 gallons of spirit which are kept constantly under cold water.

Amritsar.—Freshly made spirit is rarely put on the market. It is kept at least three weeks to a month before being sold. Rum supplied to the Supply and Transport Corps must be, according to the terms of the contract, at least three months old.

Rawalpindi.—There are no rules governing this matter, but we usually keep the spirit from two to three months if possible before putting it on the market.

Simla.—Country spirit is kept eight or nine months and whisky from two to nine years before being put on the market.

H. J. MAYNARD,

20th September 1904. *Commissioner of Excise, Punjab.*

CENTRAL PROVINCES.

No. E-923, dated Nagpur, the 27th September 1904.

From—J. T. MARTEN, Esq., I.C.S., Commissioner of Excise, Central Provinces,

To—The Under Secretary to the Hon'ble the Chief Commissioner, Central Provinces, Revenue Department.

With reference to your endorsement No. 5593, dated the 9th September 1904, forwarding a copy of Government of India's letter No. 5474-S.R., dated Simla, the 30th August 1904, and enclosures, on the subject of the deputation of Major C. H. Bedford, I.M.S., for the purpose of enquiring into the quality of country spirit, I have the honour to forward a statement which contains the information called for so far as it can be supplied by this office.

2. In respect of the enquiry in paragraph 2 of the Government of India's letter as to what distilleries it would be profitable for Major Bedford to visit, I would suggest the distilleries of Akola and Nagpur as being convenient and representative. It would be interesting and might be useful if Major Bedford could conveniently arrange to visit the latter place sometimes towards the end of October when Mr. Todhunter and myself are likely to be there.

Statement showing the information required in Government of India, Finance and Commerce Distilleries in the

1		2		3		
Name of Distillery.		Class of still used.		Materials used in the preparation of the liquor and their proportion.		
		(a)	(b)	(a)	(b)	
District.	Distillery.	Nature of still.	Approximate capacity (gallons).	Particulars of materials.	Proportion of materials per maund of Mohwa.	
					Of spent wash. Gallons.	Of water. Gallons.
Nagpur	1 Nagpur	(a) Persian still	1,200 (4 stills)	Mohwa, spent wash and water yeast and Nim leaves are sometimes used.	...	...
	2 Katol	Do.	260	Mahua spent-wash and water.	...	...
	3 Umrer	Do.	225		...	...
Wardha	4 Wardha	Do.	562½		12½	18¼
	5 Hinganghat	Do.	336		12	24
	6 Arvi	Do.	400		...	...
Bhandara	7 Bhandara	Pot-stills	38		...	...
	8 Paoni	Do.	40		...	...
	Outstills	Pot-still	...		...	...
Chanda	9 Chanda	Persian still	165		...	...
	10 Warora	Do.	172		7½	15
	Outstills	Pot-still	...		...	...
Balaghat	11 Balaghat	Pot-stills	40		...	...
	Outstill	Pot-still	...		...	...
Jubbulpore	12 Jubbulpore	Persian stills	Two stills 285 and 360.		7½	23⅕
	13 Murwara	Pot-still	24		5	15
	Outstill	Do.	...		...	...
Saugor	14 Saugor	Persian still	325		...	...
	Outstills	Pot-still	...		...	...
Damoh	Do.	Do	...		...	...
Seoni	15 Seoni	Persian still	175		...	...
	Outstill	Pot-still	...		...	...
Mandla	Do.	Do.	...		...	...
Hoshangabad	16 Hoshangabad	Persian still	400		3	6
	Outstills	Pot-still	...		...	...
Narsinghpur	17 Narsinghpur	Persian still	120		...	...
	Outstills	Pot-still	...		...	...
Betul	18 Betul	Pot-stills	28		...	...
	Outstills	Pot-still	...		...	...
Chhindwara	19 Chhindwara	Do.	8		...	...
	Outstills	Do.	...		...	...
Nimar	20 Khandwa	Persian still	100		$\frac{9}{15}$	10 to 15
	Outstills	Pot-stills	...		...	...

Department, letter No. 5474-S.R., dated the 30th August 1904, in respect of the Sadar Central Provinces and Berar.

4	5		6	7	8
	Period required for fermentation.				
Details of process employed.	(*a*)	(*b*)	Time that elapses between the completion of fermentation and distillation.	Average strength of the spirit taken from the receivers (in terms of proof spirit).	Rules regarding the maturing of spirit.
	In the hot season.	In the cold season.			
	Days.	Days.			
Simple fermentation often much too long prolonged and distillation over a direct fire usually till all the spirit is exhausted.	...	...	The distiller passes the wash to the still as soon as he thinks that the fermentation is complete.	3 strengths are drawn off at different stages, 50° to 52°, 45° to 47° and 10° to 12°.	There are no rules requiring the maturing of spirits and spirit is seldom kept in practice for more than a few weeks.
	...	...			
	...	...			
	3 or 4	...		2 strengths 25° to 30° and 60° to 65°.	
	4	6		65°	
	...	...			
	...	...			
	...	...			
	...	...			
	...	...			
	...	7			
	...	...			
	...	...		65° to 70 ...	
	...	...			
	4 or 5	7 or 8		3 strengths are drawn off at different stages, 60° to 62°, 45° to 47° and 20° to 25°.	
	5	11			
	...	...			
	...	...			
	...	...			
	...	...			
	...	...		70,° 60° & 40° (3 strengths) ...	
	...	...			
	...	...			
	5 to 6	9 or 10		65° to 70° ...	
	...	...			
	4 to 5	6 or 7		2 strengths 50° to 52° and 25° to 27°.	
	...	...			
	...	...		2 strengths 66° and 25°	
	...	...			
	...	...			
	...	...			
	4	6			
	...	...		2 strengths 10° to 12° and 45° to 47°.	

Statement showing the information required in Government of India, Finance and Commerce Distilleries in the

1		2		3		
NAME OF DISTILLERY.		CLASS OF STILL USED.		MATERIALS USED IN THE PREPARATION OF THE LIQUOR AND THEIR PROPORTION.		
		(*a*)	(*b*)	(*a*)	(*b*)	
District.	Distillery.	Nature of still.	Approximate capacity (gallons).	Particulars of materials.	Proportion of materials per maund of Mohwa.	
					OF SPENT WASH Gallons.	OF WATER Gallons.
Raipur	21 Raipur	Persian still	Two stills 337	Gur is also sometimes used.	2	28
	Outstill	Pot-still	...	Mohwa spent wash and water	...	...
Bilaspur	22 Bilaspur	Persian still	125		5½	13½
	Outstill	Pot-still	...		...	...
Sambalpur	23 Sambalpur	Persian still	40		9¾	24
	24 Bargarh	Do.	47 & 50		...	...
	Outstills	Pot-still	...		...	...
	Berar.					
Akola	Akola	Steam still	Two stills of 4,200 & 2,100		...	30
Ellichpur	Ellichpur	Do.	4,800		...	...
Elsewhere	Outstills	Pot-stills	...		...	...

NOTES.—(*a*) The Persian still used in the Central Provinces consist of a copper boiler heated

(*b*) The steam stills at Akola and Ellichpur consist of wooden vats with steam coils

Department, letter No. 5474-S. R., dated the 30th August 1904, in respect of the Sadar Central Provinces and Berar—(concld.)

4	5		6	7	8
Details of process employed.	Period required for fermentation.		Time that elapses between the completion of fermentation and distillation.	Average strength of the spirit taken from the receivers (in terms of proof spirit).	Rules regarding the maturing of spirit.
	(*a*) In the hot season.	(*b*) In the cold season.			
Simple fermentation often much too long prolonged and distillation over a direct fire usually till all the spirit is exhausted.	Days.	Days.	The distiller passes the wash to the still as soon as he thinks that the fermentation is complete.		There are no rules requiring the maturing of spirits and the spirit is seldom kept in practice for more than a few weeks.
	4 to 6	9 or 10			
	...	...			
	5	7		50° to 60° & 25°, two strengths.	
	...	...			
	5	6 or 7		60° ...	
	...	...			
	...	...			
	5	3 or 4		Not known. The first distillation is stopped when the spirit running from the still reaches a strength of 82° U. P. but all the spirit made is re-distilled and reduced to issue strengths with distilled water before issue.	
	...	...			
	...	...			

by direct fire over which in an inverted wooden vat with a goose-neck attached.
passing through them and goose-neck attached.

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